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AUGUST 1937

THE STORY OF TIDE WATER ASSOCIATED

ITALIAN HYDROGENATION OF ALBANIAN CRUDE

ECONOMIC LIMITS OF EAST TEXAS PRORATION

DRILLING IN ILLINOIS

FIRST CHOICE IN THE OIL FIELDS

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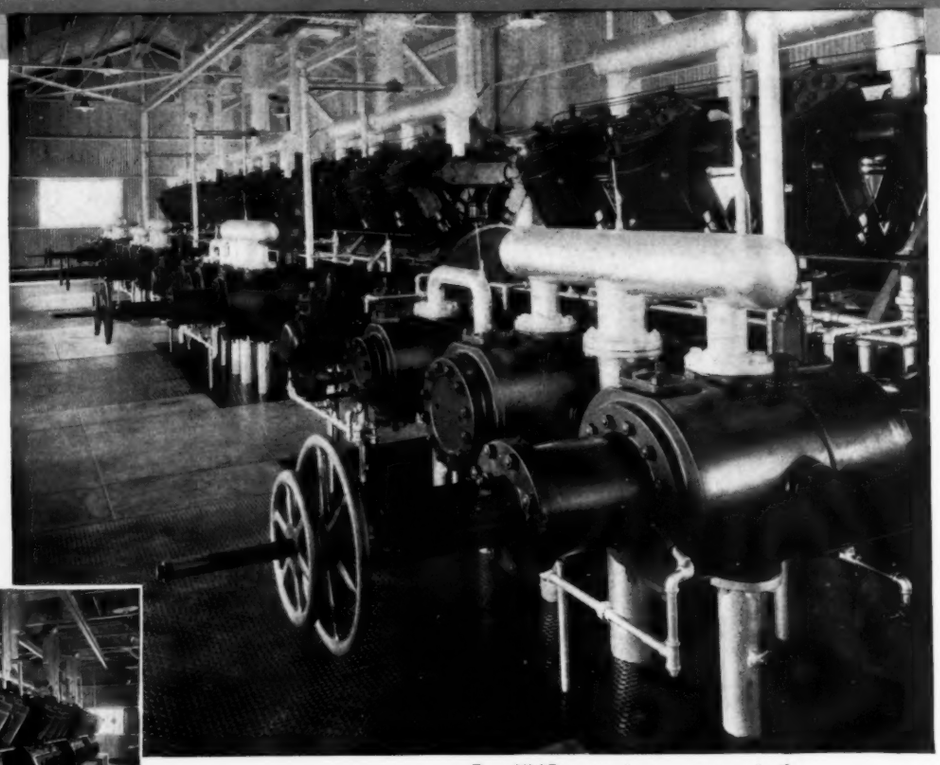

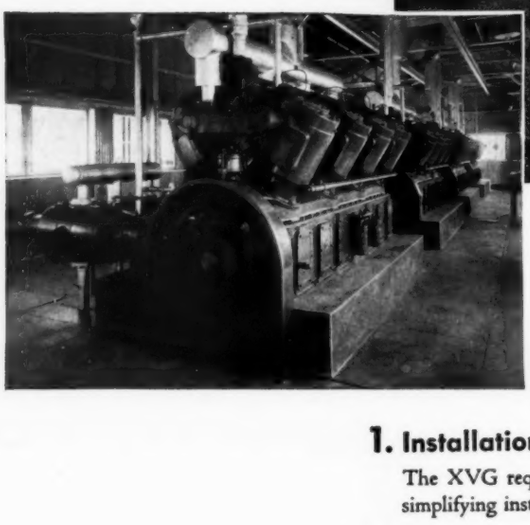

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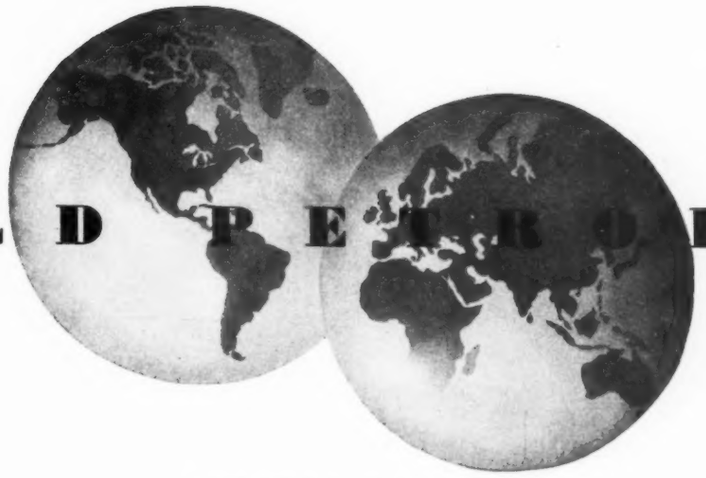

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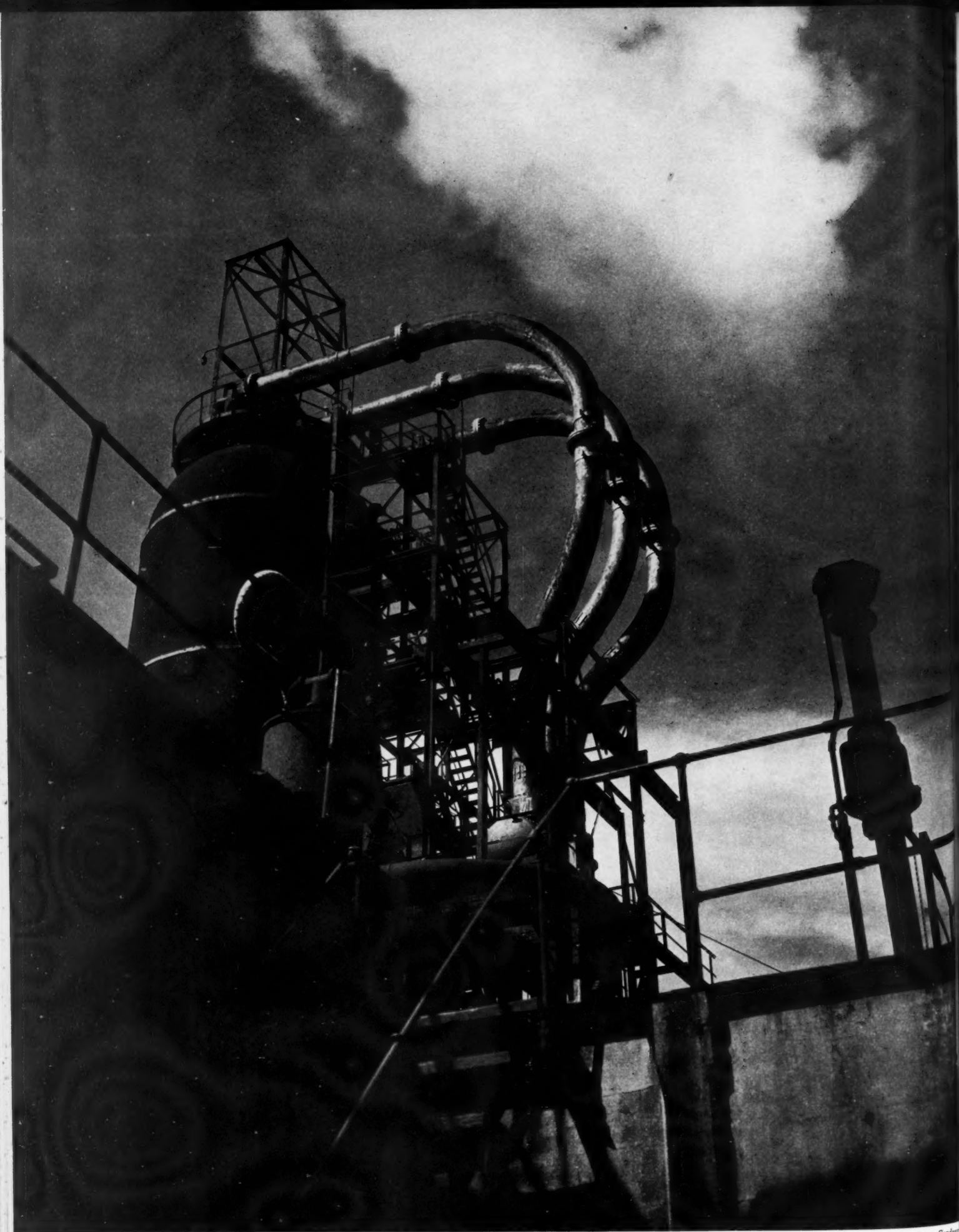

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Tide Water Associated Oil Company's refinery at Bayonne, New Jersey

EDITORIAL

OIL INDUSTRY'S GOOD OUTLOOK

STRONGLY entrenched statistically and facing a rapid growth in demand for its products throughout the world the petroleum industry enters the later months of 1937 under the most favorable conditions that have surrounded it for the past dozen years with the prospect of steady progress and general stability in the immediate future. While prices are still below the average of the decade 1920-30 they are definitely on the upgrade. As a result of technical advances which have increased the proportion of the more valuable products recoverable from a barrel of crude it is possible for refiners to operate on a narrower margin than was the case ten of fifteen years ago. Consequently, the present adjustment, while not entirely satisfactory to all branches of the industry, permits fairly profitable operation, particularly since it is accompanied by a much larger volume of total business.

In the United States, which still remains the chief factor influencing petroleum trade, crude production has definitely established itself at a little over 3,500,000 barrels (500,000 tons) daily. This is an increase of slightly more than 10 percent since the beginning of the year. Production has run consistently above the advance estimates of requirements prepared by the United States Bureau of Mines. In the early months of the year it was in excess of actual demand but an embarrassing accumulation of stocks has been prevented by the rapid rise in demand.

CRUDE oil stocks on July 17 of 307,000,000 bbl. actually were less than on the corresponding date in 1936 when they stood at 310,000,000 barrels though they were 23,000,000 barrels higher than on January 30 last. Motor fuel stocks, which caused some uneasiness in the trade by rising to a record figure of 83,538,000 at the end of March, have declined as steadily since the season of heavy demand set in. By July 10 they were down to 72,546,000 barrels or less than 8,000,000 barrels above their level in July 1936. That this difference could be quickly wiped out is shown by the drop of 1,430,000 barrels in gasoline stocks in the week ending July 17.

Statistics of stocks, however, have less meaning when given in gross figures than when stated in terms of days supply. On the latter basis both crude and refined stocks are relatively smaller than they were a year ago. At the current rate of consumption gasoline stocks on hand July 10 amounted only to 51 days supply while crude stocks were equivalent to 90 days supply. This is regarded by marketing authorities as a normal supply and one that could not be greatly reduced with safety.

Surprising in its proportions has been the upswing in consumer demand which has corrected what otherwise might have been put down as excesses in production and has prevented the accumulation of unwieldy stocks. At the end of 1936 the increase of over 10 percent in motor fuel demand during that year was characterized as a remarkable development. Commentators, ourselves included, agreed that it would be too much to expect a similar proportionate growth in 1937. An increase of 7.5 percent was put down as a reasonable expectation. Yet we find in the first half of this year a jump of 12 percent in motor fuel consumption over the corresponding six months of 1936. The number of motor cars on American highways has attained an all time high and the mileage traveled per car is likewise increasing.

Prices have risen approximately in the same proportion as production and demand. Gulf export price for gasoline has risen from 5¾ cents per gallon to 6⅜ cents since January. East Texas crude has advanced from $1.15 to $1.35 per barrel. Domestic retail prices for gasoline have increased from half a cent to one cent per gallon, these prices as usual showing a tendency to lag behind the improvement in crude. Price cutting competition in motor fuel has been less in evidence than in any corresponding period in the past four or five years. In this respect the market situation is an encouragingly healthful one.

To a great extent the rise in price levels has been forced by increasing costs, due particularly to advances in wages but also in all other operating charges. Actually the rise in retail prices of products thus far has not been sufficient to absorb these added costs.

CONDITIONS in the United States are a fair replica of those in the world at large. Demand everywhere shows a rapid increase, stocks are not unduly large and prices show a strengthening tendency, though not advancing in like proportion with costs. Fundamentally, however, conditions in the world oil industry are sound and the

outlook for the immediate future is more encouraging than at any previous time since the start of the industrial depression. While there has been much discussion of the influence of recurrent war scares in leading various countries to accumulate large stocks of petroleum products for purposes of defense, and while this has been, and still is, a factor of some consequence in the export trade, it is of far less importance than the general growth of industrial activity throughout the world.

For the present and for the future, for as long a period as can now be foreseen, the problem before the oil industry is to locate and make available the ever increasing supplies which a motorized civilization is demanding in greater and greater quantities. Appreciation of this fact is attested by the drilling of nearly 14,000 wells in the United States during the first half of 1937, a number greater than in any previous half-year except 1920, and by the far flung activities of exploring and drilling expeditions in the most remote parts of the world where the slightest promise of undiscovered oil can be held to exist.

THE MUSCOVITE MYSTERY

LONG before Lenin, with an ease that astonished himself, took over the vast Muscovite Empire, Russia had often proved an enigma to the rest of the world. Never before, however, have the peoples of other nations been in such a state of puzzlement over events in the Soviet states as has been induced by developments of the past few months. Trials and executions on charges of treason, conspiracy and sabotage long since have ceased to be a novelty, but these latest blood purges, extending from White Russia to the furthest reaches of Siberia, and embracing all classes from humble railway workers to the top ranks of the vaunted Red Army, leave the onlooker gasping in astonishment.

If the dictatorship of the proletariat which the leaders of the revolution theoretically set out to establish were actually in effect it would be easier to understand the periodic slaughter because history has shown, as in the French revolution and on many other occasions, that no other group can be more cruel, bloodthristy and unreasoning than the long-oppressed, once they take power into their own hands. But Russia has moved far from even the semblance of proletarian rule. It is a compact, close bound autocracy directed by a group that has grown smaller and more despotic as those in its innermost circle have removed the associates whom they distrusted for their liberalism or envied for their ability. For twenty years the Soviet Union has stood as the ideal of those who believe that the State should be everything, the individual nothing; who hold that a nation can be governed by propaganda and a people shaped to the image set up by those who, in supreme egotism, take charge of its destiny. Is it possible that there is some flaw in the formula, some fatal weakness in the situation? It begins to appear so.

If disloyalty and subversive activity are as widespread as official statements would indicate Trotskyism fails utterly as an explanation. To imagine that the fugitive Trotsky, stripped of his authority and forced to move from country to country to find asylum, can reach within the iron ring of the Comintern and stir up sedition in every part of its domain is to endow him with power that even the deified Lenin never displayed. Similarly, to attribute the seduction of men in all ranks and branches of Soviet service to the diabolical cleverness of Japanese and German espionage is to put a strain on credulity. Corruption with such ease and on such a scale suggests the application of Hamlet's remark about the State of Denmark.

Reports published in our own pages from month to month indicate that suspicion, accusation, and denunciation are rife in every field of activity. Konstantin Riabovol who accompanied the Russian delegation to the oil stabilization conference in New York in June, 1932, and who has recently been a director and important official of Grozni, has been denounced as a Trotskyist and removed from his position. Whether Riabovol will escape with his life is as yet uncertain. Quoting from an article in the June 1932 issue of World Petroleum throws some light on the profound changes that have occurred in Russia, weakening every department of the state from industry to army:

"Riabovol is the strong man of the delegation," said this article. "His loyalty to the party has never been questioned and he has never been exposed to the dangers of capitalism. The fact that he was included in the delegation although he speaks no language but Russian is a key to the strength of his position."

Thus 1932: in 1937 (apparently the end of another unofficial Five-Year era) Riabovol, Ganshin, head of Bashkiria, and many other stalwarts whose loyalty had never been questioned, are being denounced, removed and sometimes executed as Trotskyists.

Petersen and Bortz were removed from Baku in May. Their present condition and whereabouts are not known. Plan fulfillment at Baku jumped from 97 percent to 102 percent. Having, as they think, produced this effect by removing heads of the trust, Soviet accusers are turning their attention to other trusts that are lagging behind plan. Grozni, with only 66 percent plan fulfillment has already suffered the removal of Riabovol. It is almost possible to pick the spots where the ax will strike next: Bashkiria, 51 percent plan fulfillment; Emba, 51 percent; Varoshilov, 22 percent; Kalinin, 64 percent.

Meanwhile, officials are petrified with fear. Action, based on a mistake in judgment, means almost certain exile or death. No action at all may mean the same thing but less inevitably.

Obviously progress in industrialization can not be built on the ruin of the ablest men in the country, nor can the Soviet claim of an early return to its former importance in the international oil trade be fulfilled through wholesale executions and the liquidation of the very men who possess the brains and experience needed to bring about such an achievement.

TIDE WATER ASSOCIATED OIL COMPANY

A Major Unit in the Petroleum Industry

Two Oil Companies, Starting in Pennsylvania and on the Pacific Coast a Few Years Apart Built Important Integrated Organizations Based Largely on Substantial Crude Oil Reserves, Strategic Location of Pipelines, Leadership in Refining Technique and Development of Wide-Spread Marketing Outlets, Merged in the Autumn of 1936; and Now Operate as a Major Unit in the Oil Industry.

William F. Humphrey, president, Tide Water Associated Oil Company.

RECENT MERGER of Tide Water Oil Company, operating in the East and Mid-Continent, and Associated Oil Company, operating on the Pacific Coast, with and into Tide Water Associated Oil Company as the surviving corporation, has placed the consolidated company well in the front rank of the major units in the petroleum industry. While Tide Water Oil Company and Associated Oil Company were previously affiliated through Tide Water Associated as a holding company, the recent physical merger is designed to result in a true integration of the entire organization into one of maximum strength and efficiency. The merger and the refinancing program accompanying it, will effect substantial savings to the company and its stockholders.

In the past the number of oil companies engaged in world wide operations has been relatively small but with the opening of a new era of expansion in demand, with military and industrial requirements rapidly increasing and with the problem before the oil industry one of maintaining adequate supplies for a constantly broadening market an opportunity has been presented to some of the next-in-line companies to move up among the industrial leaders. For those already possessed of abundant reserves the prospects of expansion are particularly bright.

This is where the Tide Water Associated Oil Company stands at this time. The factors for success on a large scale seem all to be present. Its crude reserves are coupled to a well established transportation system, efficient manufacturing facilities and a widespread marketing system. The company is well seasoned in all branches of the business and is possessed of another valuable asset which will be touched on later, since, in the period ahead, it will have great bearing on the progress made from this present advantageous position.

From its properties in many parts of the Union, Tide Water Associated produced, during the year 1936, approximately 20,000,000 bbl. of crude, and at the current rate of production the aggregate for 1937 will substantially exceed that of last year. The properties are capable of producing a larger volume of oil, but voluntary or compulsory curtailment regulations limited such production during the past several years. The company has more than 600,000 acres of developed and undeveloped land in 14 states. Its producing properties are in California, Oklahoma, Kansas, Texas, New Mexico, Illinois, Pennsylvania and Louisiana. It has important holdings in the East Texas, Conroe, Cayuga and Long Lake fields in Texas, the Bradford area in Pennsylvania, the Billings field in Oklahoma, Rodessa field in Louisiana, and the Ventura Avenue, Kettleman Hills, San Joaquin Valley, and Los Angeles Basin fields in California. As of December 31, 1936, it had 3,265 producing oil wells and 1,601 oil wells shut in. The latter are capable of producing but are shut in to comply, in an overall manner, with conservation programs. In addition, the company had 46 operating gas wells and nine shut in.

While widely scattered, most of the company's production is readily accessible. Its wells in Texas and Louisiana are convenient to Gulf ports. The production in Illinois and Pennsylvania goes to the seaboard in the company's own pipeline. In California, the Los Angeles Basin fields are at the harbor gates, as is the backlog of the company's California reserve, at Ventura

Laying one of the early pipelines, which formed the basis of Tide Water's present great structure. Photograph taken in the Spring of 1887 on the Keefer farm west of the Delaware River.

San Joaquin Valley oil is carried north to San Francisco Bay in twin pipelines that pass within easy reach of many of the important producing or prospective areas, and still another line leads down to salt water at Monterey Bay, where the company has built a unique submarine loading line for filling tankers well offshore.

During the financing program in connection with the recent merger, an independent petroleum engineer appraised the net crude oil reserves of the company at more than 335,000,000 bbl. Through acquisition and extension of producing properties and development of properties owned and leased, it is estimated by the company's engineers that at the end of the year 1936, notwithstanding that approximately 20,000,000 bbl. of crude oil had been produced during the year, its reserves had been increased 11,800,000 bbl. over and above the reserves estimated by them as at the beginning of the year.

In a general way, it must be regarded as most favorable that these crude reserves and the crude purchasing facilities afforded by the several pipelines, are convenient to the Panama Canal. In a period of shortage or other stress, the canal will make it possible for either division of the company to supply the other with crude or products as occasion may require, yet with world markets in a normal state of balance, the Eastern Division (Tide Water) can take advantage of good European markets, and in the West, the Associated Division has the whole Pacific offshore market at its door.

Long before there was any thought of merger of Tide Water Oil Company and Associated Oil Company, the two companies held curiously similar traditional policies with respect to the development of production. While there is evident, in both family trees, a tendency towards drilling in proven fields, or at least in territory so close to production that the probability of pay was high, each of the units has been progressive in wildcatting in undeveloped areas.

Associated Division is, in fact, credited with several discoveries in California and has been particularly successful in finding new deep zones in old fields and, it will be developed later, the very foundation of the original Tide Water Oil Company followed a long initial line of wildcat wells.

Both divisions today are maintaining able geological and land department staffs, and utilize geophysical survey methods wherever conditions and opportunities warrant. This policy of "informed caution" has justified itself by giving the best dollar return in adding new reserves.

The transportation system maintained by the company includes over 3,000 miles of trunk and gathering pipelines, nearly 2,000 tank cars, and some 1,400 motor vehicles. The marine department operates 17 seagoing tankers and 27 harbor crafts with a combined carrying capacity of 1,500,000 bbl.

The huge refinery at Bayonne, New Jersey, is the focal point of operations in the East; and that at Avon, California, on San Francisco Bay, is of almost the same importance on the Pacific Coast, though not quite, because it is supplemented by an ample plant at Watson—the Los Angeles Harbor refinery center. The plant at Drumright, Oklahoma, supplies the Mid-Continent market from crude produced by the company in the Mid-Continent area. Tide Water Associated also owns a 50 per cent interest in the Mitsubishi Oil Company, Ltd., which operates a thoroughly modern and complete refinery, with cracking equipment, at Kawasaki near Tokyo, Japan. Crude oil, including that suitable for lubricating oils, is now supplied to this plant from Tide Water Associated's California production.

Reconstruction and addition of new units keep the company's refineries thoroughly modernized. Capacity has been built safely beyond requirements, the combined charging capacities of Bayonne, Drumright, Avon and Watson being 127,500 bbl. of crude oil daily through crude stills and 56,500 bbl. daily through cracking stills. All plants have been engineered for efficiency by such organizations as Alco, Badger, Lummus, Foster Wheeler, and other leading engineers.

Alco is now constructing additional cracking facilities at the Avon Refinery that will raise the cracking capacity by 7,500 bbl. to 28,500 bbl. daily. Authority has also been granted for installation of polymerization facilities including the Girbotol process. The new cracking equipment will afford an improvement in yield and according to recent estimates, will increase the production of cracked gasoline by 633,000 bbl. per year. It is estimated that the polymerization facilities will produce 180,000 bbl. annually of gasoline of premium value. The combined cracking and polymerization equipment, costing approximately $2,000,000, will permit the

manufacture of the present total gasoline requirements of the Associated Division with a reduction of at least 1,428,000 bbl. of crude oil per year. The installation of these facilities may be likened to the equivalent of a crude oil reserve producing at the rate of 3,900 bbl. daily during the life of the facilities.

In the manufacture of lubricants, the company has long maintained a noteworthy prestige. Its Veedol oils are manufactured from the highest quality Pennsylvania bright stock and neutral oils. In the West, Associated Division manufactures an excellent lubricating oil—Cycol—from California crude in the company's Edeleanu solvent process plant. This brand is a leader among western oils. Both lines have made a glowing record in the gruelling Navy work tests for lubricants and enjoy a wide and profitable market.

In its eastern marketing area and in the Mid-Continent states, Tide Water Division has well rounded facilities for distributing Tydol gasoline and Veedol motor lubricants. Tydol lubricants have an exceptional acceptance among industrial plants requiring quality lubricants. The company also does a large export business and its products are distributed in 55 countries throughout the world.

In the West, the Associated Division has a distinguished record of accomplishments in marketing. The distributing structure is

Edward L. Shea, executive vice-president, Tide Water Associated Oil Company.

complete throughout the Pacific Coast states and in the Philippine and Hawaiian Islands. A customer service developed through its own retail outlets and by intensive cooperation with select independent retailers, coupled with top quality products, has carried the company into an enviable position in point of volume. Of the major oil companies in the Pacific Coast area today, none has a better developed affiliation with independent retailers. Brands are well established.

At the time of the recent merger, the Board of Directors of the Tide Water Associated Oil Company was enlarged to include such of the officers and directors of Tide Water Oil Company and Associated Oil Company as were not then directors of the parent company. The Board of Directors is now composed of men listed in the accompanying table.

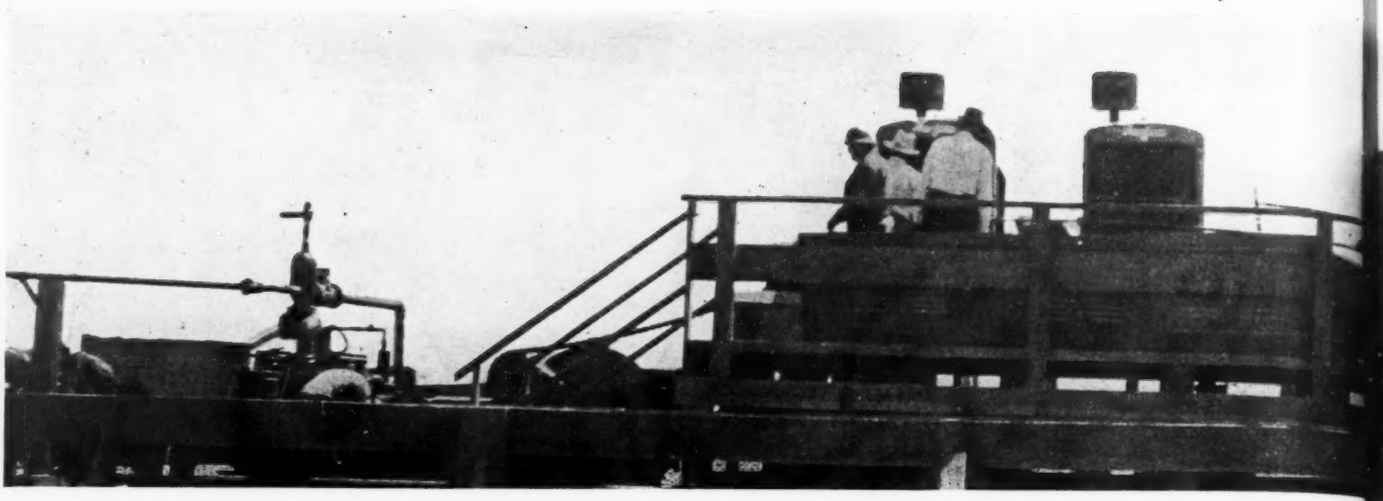
DIRECTORS

Alden Anderson	John Hertz
George N. Armsby	John J. Hopkins
Lloyd F. Bayer	William F. Humphrey
Carl H. Beal	L. D. Jurs
Adolphe Boissevain	Robert McKelvy
Charles M. Cadman	Ralph B. Pringle
J. A. Chanslor	Noel Robinson
Henry W. De Forest	Edward H. Sarin
John F. Forbes	Edward L. Shea
B. I. Graves	Paul Shoup
H. Paul Grimm	Elisha Walker
Frank Haskell	Olin Wellborn III

EXECUTIVE OFFICERS

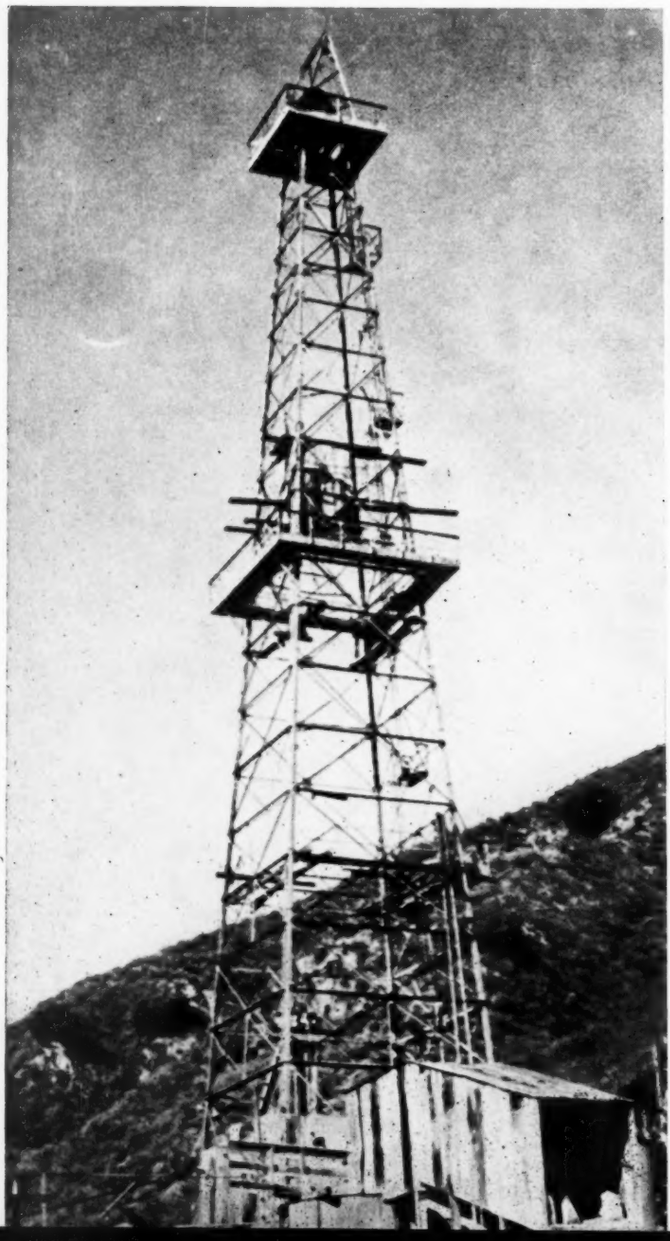
President:	William F. Humphrey,
Executive Vice Pres.:	Edward L. Shea
Vice Presidents:	C. R. Barton, New York L. F. Bayer, San Francisco J. D. Collins, New York L. C. Decius, San Francisco B. I. Graves, San Francisco George J. Hanks, New York J. H. Jenkins, San Francisco L. D. Jurs, San Francisco Robert McKelvy, New York R. B. Pringle, Tulsa Noel Robinson, New York R. E. Ryerson, New York Edward H. Sarin, Houston
Treasurer:	K. R. Hankinson, New York
Secretary:	W. J. Barker, New York
Exec. Secretary:	J. P. Edwards, San Francisco
Comptroller:	Walter Glasser, New York

Original pumping station fifty years ago on one of Tide Water's first pipelines, at Shumans, Pennsylvania.



Present drilling on the Pacific Coast and elsewhere has assured the company adequate reserves for the future. The picture shows a 150 h.p drilling unit operating on butane at Associated's No. 1 Taylor, near Lost Hills, California.

President Humphrey, a resident of San Francisco, first became connected with the company in October 1925, when he was elected a director of Associated Oil Company. On August 1, 1926, he was appointed chief counsel of that company, and on August 15, 1926, was elected chairman of the board of directors, A year later he was elected to the presidency of the Associated Oil Company. In May 1933, Mr. Humphrey was elected president of the Tide Water Associated Oil Company and chairman of the board of directors of Tide Water Oil Company, retaining the presidency of the Associated Oil Company. These latter positions were abolished at the time of the merger, effective November 30th, 1936. Great progress has been made by the company under Mr. Humphrey's direction. The recent merger and financing program were completed under his direction.

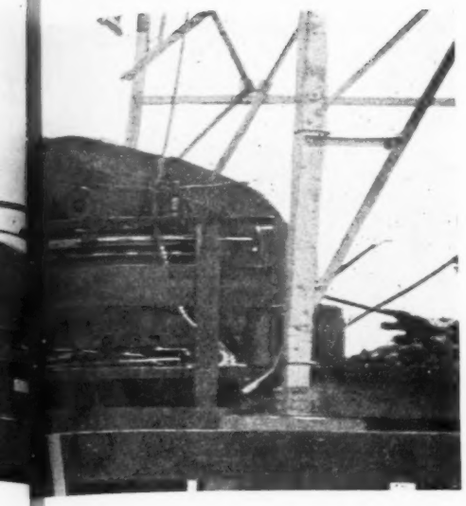


McGonigle No. 12, completed by Tide Water Associated Oil Company in California at a depth of 10,569 ft., until recently the deepest producing well in the world.

Edward L. Shea, executive vice president of Tide Water Associated Oil Company, entered the employ of its former subsidiary, Tide Water Oil Company, after graduating from Princeton University in 1916. His first employment was at the Bayonne refinery and after working in various capacities in the United States and Mexico he was brought to the New York office where he served as vice president in charge of manufacturing and sales. In 1932 he was appointed executive vice president of Tide Water Oil Company in charge of all operations, and in 1933 was elected president of that company. This position Mr. Shea held until the completion of the merger of Tide Water Oil Company and Associated Oil Company with and into Tide Water Associated Oil Company in November 1936, at which time he was elected executive vice president of the latter company

ORIGIN OF TIDE WATER

Seventeen dry holes in the backwoods of Pennsylvania, a few miles from Titusville, represented in the late sixties the petroleum assets of a company destined to become one of the country's great integrated oil organizations. They belonged to the Enterprise Oil and Lumber Company. The moving spirit in the company, and in fact its sole owners, were two young men who had gone through the Civil War, one as a



Union officer and the other as the youthful sheriff of Onondaga County, New York.

No whit discouraged by their seventeen failures were these youthful capitalists—Byron D. Benson and Major Robert E. Hopkins. They were young, adventurous, but not reckless. Before the war they had had some experience in the lumber business. Since that time oil had become a magnet that drew thousands of men from all ranks of society to Western Pennsylvania. Many gambled their all upon a single well and lost. Many others invested in leases of land where no oil was ever found. The possibilities in this strange new industry appealed to Benson and Hopkins but it did not cause them to overlook its hazards. They knew lumber and they decided to make it their avenue of approach to oil. Their first lease was taken on some excellent timber land equipped with a sawmill. It was located at Enterprise, a northwestern Pennsylvania village.

For the first few years, the lumber end of the business was far more lucrative than its oil activities. While the dry holes were going down the sawmill was busily working big logs into merchantable lumber and the proceeds from the sales of the latter kept the drills going. In five years the partners learned a lot about the oil business and the sales of lumber had enabled them to pay for their experience as they went along. In 1870 they were joined by a young lawyer named David McKelvy who had handled their legal affairs. The firm became D. McKelvy & Company. It acquired other acreage, put down other wells which were good producers, and made what one of their descendants describes as a "moderate fortune" out of the business.

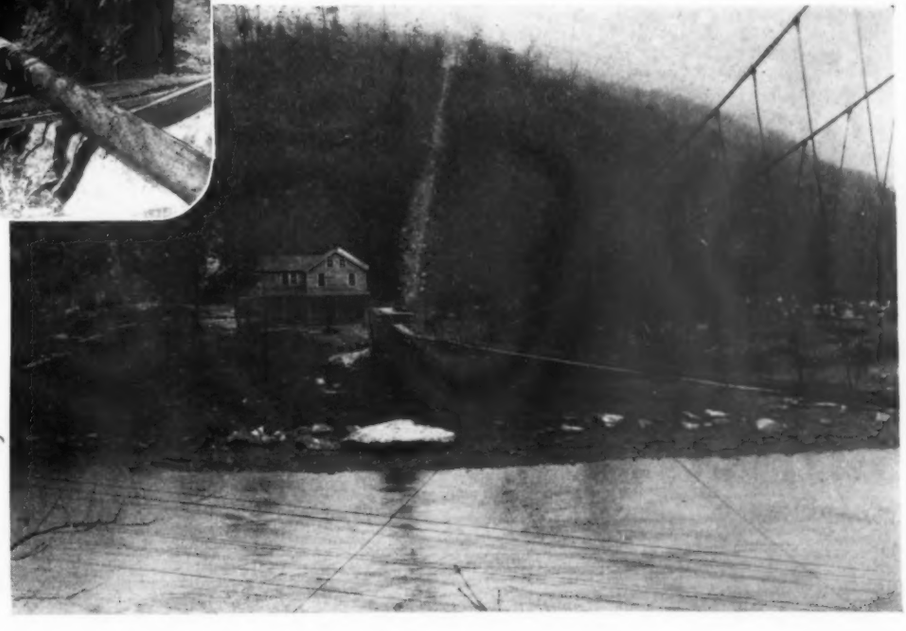
In those early days the risks of the petroleum industry did not end wi h the discovery of oil. Prices fluctuated wildly, costs of transportation were excessively high, storage was not available, and not infrequently oil ran to waste because shipping facilities were lacking or because the price obtainable was not high enough to cover the cost of moving the oil to market. The situation was made worse for small independent producers by the gradual consolidation of refineries into a single group and by the alliance between that group and the railways. As a result, the rates charged to outside producers by the railway lines rose higher and higher.

The situation was one that caused the members of D. McKelvy & Company to do some serious thinking. Cheap and dependable means of moving oil from the fields to a competitive market were necessary if the independent producers were to continue in business. Trucking oil by team over almost impassable roads was out of the question except for very short distances. The pipeline seemed the only solution.

The first pipeline in the Titusville district was laid as early as 1865. It was four miles in length and could handle 60 bbl. per day. The local teamsters saw in it a threat to their business and tore it up. Nine years later Dr. Hostetter of Pittsburgh, whose almanac hung on the wall of every farmhouse kitchen and whose stomach bitters solaced many a worthy who would have scorned to use alcohol in a less piously medicinal form, constructed a much more ambitious line. It extended from Millerstown in Butler County to Pittsburgh. Its three-inch pipe was capable of handling 3,500 bbl. daily. It was out of the realm of teamster competition but the railways saw in it a menace to their control of oil transportation. At one point the pipeline passed under the roadway of a leading railway company. By the simple expedient of hooking a chain around the pipe, attaching it to a locomotive and starting up the latter, railway employees ripped apart the line.

It was after this incident that D. McKelvy & Company leased the line which was owned by the Columbia Conduit Company. They did not attempt to extend their pipe across the railway right of way but built storage tanks on each side of the track and carted the oil across the gap over a public highway. Even with this awkward makeshift the pipeline operators were able to make money.

At first the oil handled by the Columbia line was refined in Pittsburgh but that



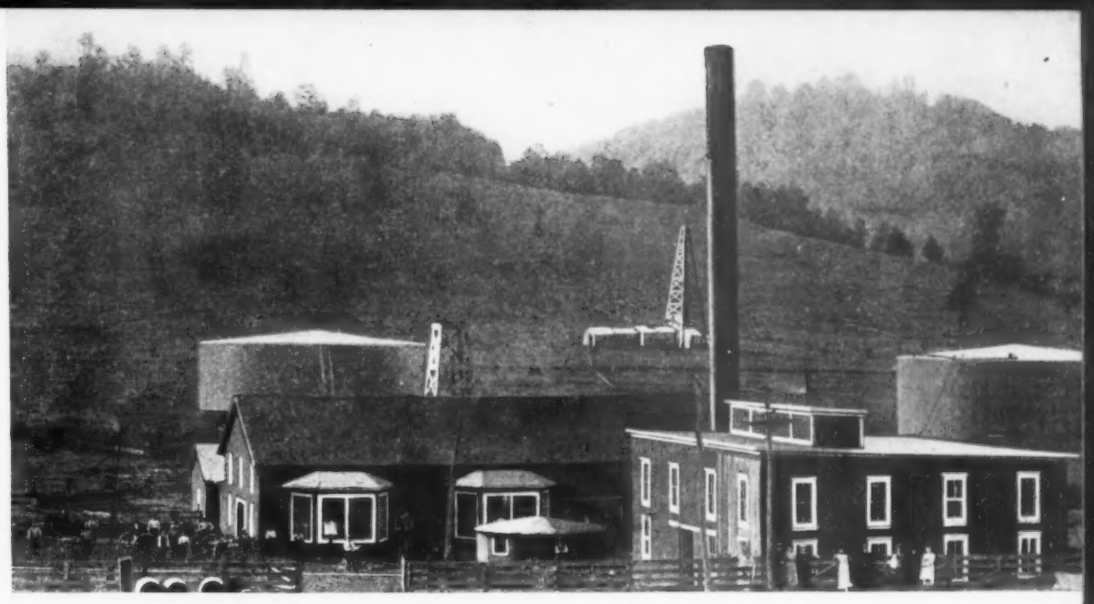
Work on the early pipelines that gave Pennsylvania producers an outlet to the markets to the east. Below, Ox Bow Bridge crossing the Lehigh Valley and Jersey Central railroads as well as the Lehigh River.

Looking east from McGonigle No. 6 into Hall Canyon, Ventura Avenue field, California. McGonigle No. 12, may be seen in the lower left hand corner of the picture, producing 536 bbl. per day from 10,569 ft.

refinery soon was bought by the rapidly growing Standard Oil Company. For a time longer an outlet was found over one of the major railroads. Pressure then was exerted upon the railroad to make it join the high priced railway group. The resourceful pipeline operators hired a barge to move their oil from the Pittsburgh terminal to Huntington, West Virginia, delivering it there to the Chesapeake & Ohio for trans-shipment to the Atlantic Seaboard. In 1877, the Standard Oil Company stepped in and bought the pipeline on which the McKelvy group held only a lease.

Balked in their plan to move their oil by way of Pittsburgh, Mr. McKelvy and his associates turned in another direction. They bought up the Seaboard Pipe Line, which had been organized a year earlier by Henry Harley with the purpose of building a pipeline from Brady's Bend to Philadelphia or Baltimore. Unable to raise the capital needed in the face of certain opposition from the railroads, the backers of the plan abandoned this particular project, but not the idea of constructing a pipeline to deep water on the seaboard. In 1878, having interested a number of other men of means, they succeeded in forming the Tide-Water Pipe Company, Ltd., with $500,000 cash capital to build a line from the rapidly developing Bradford Field to a connection with the Reading Railroad near Williamsport, Pennsylvania. That the latter was not the ultimate destination in the minds of the men behind the movement is indicated by selection of the name "Tide Water". As an immediate objective it served the purpose because of an agreement with the Reading Railroad which provided part of the capital and undertook to move the oil delivered by the pipeline at Williamsport to Philadelphia or New York.

In this new and difficult enterprise, Messrs. Benson and McKelvy had drawn a number of other men into association with them. There was John P. Townsend who had paved the way for the deal with the Reading Company, H. L. Taylor, A. A. Summer, David B. Stewart, George H. Graham, J. H. Simonds, L. H. Smith, and B. B. Campbell. In the actual construction of the line an important factor was J. G. Benton who had suggested the method used in outwitting the railroad in the operation of the old Columbia line. He became general superintendent of Tide Water and in that capacity he solved many of the problems confronting the company and

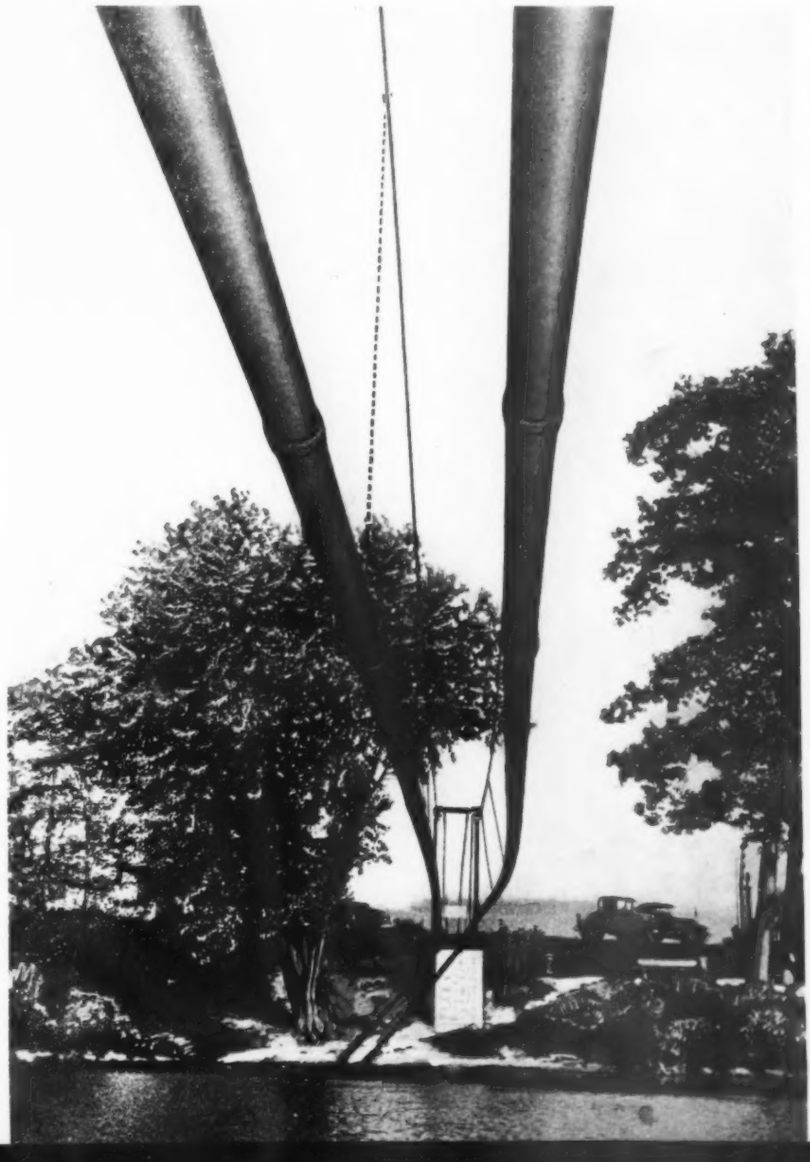


Original pumping station at Rixford, on Tide Water's pipeline that allowed independent Pennsylvania producers to compete with the companies enjoying special terms from the railroads.

ful. But Benson, McKelvy and their associates had faith in the soundness of their plans and never faltered.

The construction of this first link in the Tide Water Pipe Line over the Allegheny Mountains from Western Pennsylvania to Williamsport is an epic in the industrial development of America. It introduced a new and important phase into the organization of the oil industry and provided the necessary means of cheap and rapid transportation, that made it possible to put petroleum products in the hands of consumers at low prices that could not have been dreamed of otherwise. Alongside its monument to Colonel Drake, the members of the oil industry might well erect another to the men who built the first trunk pipeline and thereby helped break the stranglehold of the railways upon the transportation of oil.

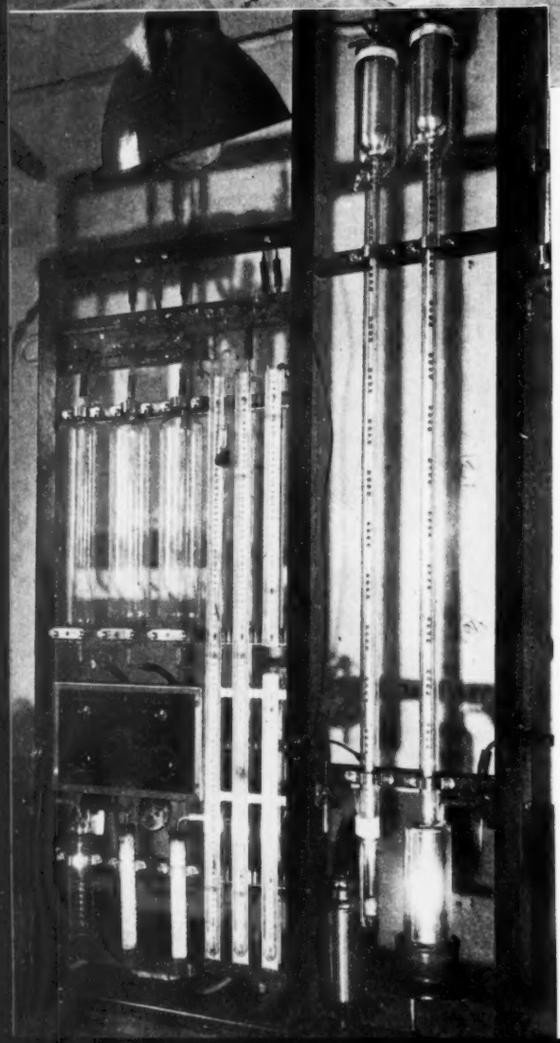
Physical obstacles to the construction of



Tide Water's pipeline crossing Fishing Creek near Bloomsburg, Pennsylvania.

devised much of the equipment used in building the line.

The daring nature of this venture is perhaps difficult to appreciate at the present time when pipelines extend over mountain ranges, under rivers, and across vast deserts. A few short lines had been built before the Tide Water pipe ine was projected but none more than 40 miles in length and none that attempted to pump oil to any such elevation as the 2,600 ft. altitude that had to be reached in crossing the Alleghenies. Prophets of failure were many. Antagonistic interests were power-



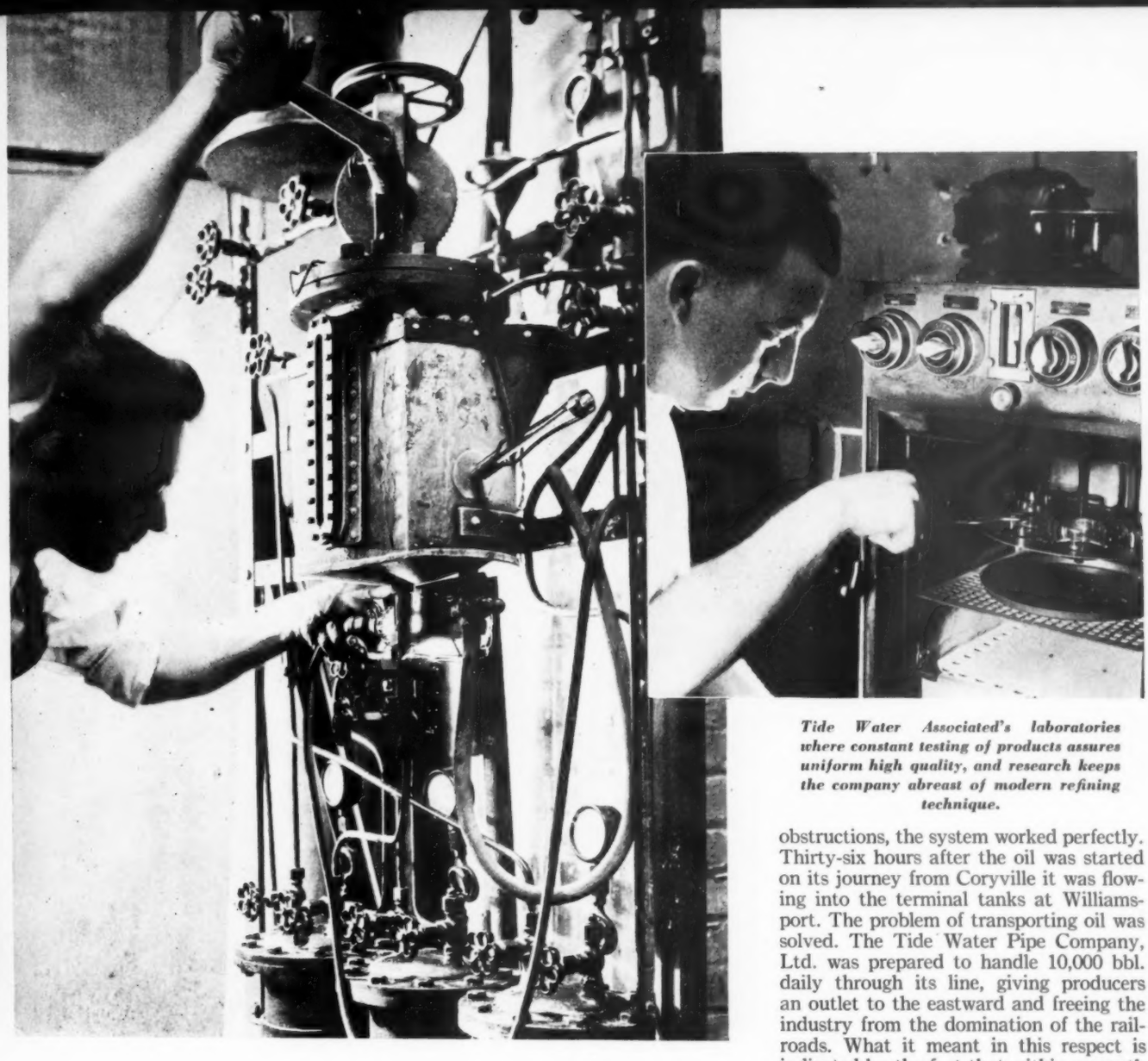
Above, a striking aerial view of the important Avon Refinery of Tide Water Associated. At left, a corner of the checking laboratory.

the line would have discouraged men less confident of themselves. The section of the system first projected was a little over 100 miles in length, much of it a trackless wilderness. The route lay through mountainous country, heavily wooded, far from railways and with few roads. Many oil men predicted that it would prove impossible to carry oil over the mountain ranges. The plans called for the use of six-inch pipe while three-inch was the largest that had been used previously. Special tools for handling the pipe had to be devised as they were not in existence.

It was in this connection that Mr. Benton proved his exceptional value to the company. Aided by Mr. McKelvy, he designed pipe tongs, jacks, jack boards, swabs, and other specialized equipment. Specifications had to be worked out for gate valves, flanges, and unions that would withstand the high pressures proposed for the line. The pipe itself had to be of unusually high quality. Looking back it is remarkable to note how much of the standard equipment in use in the oil industry today owes its origin to the builders of the first Tide Water trunk line.

One conclusion reached by Mr. Benton while he had been in charge of the earlier Columbia line was that the ordinary direct acting pump of the period was not suitable for pipeline work because it did not utilize the expansive power of steam efficiently. He recommended a triplex pump with the plungers so arranged as to provide uniform pressure. When the first of these pumps was built the walls of the cylinders and valve chests were so porous that the oil came through under the pressures applied. This condition was remedied, however, and the pumps built according to Mr. Benton's proposals operated at low cost and high efficiency for many years after other improvements in pumping machinery had been developed.

The task of obtaining rights of way for the line offered many difficulties. The railroads interposed obstacles, acquiring options on some of the lands the line was to cross. Farmers were afraid that the pipe might explode and would not let it pass



Tide Water Associated's laboratories where constant testing of products assures uniform high quality, and research keeps the company abreast of modern refining technique.

near their buildings. Representatives of the company participated in some exciting races and close finishes in obtaining and recording titles. This part of the work was completed during 1878, however, and a route was cleared along the right of way and around the sites of the two pumping stations, one of which was to be located at Coryville, the starting point of the line, and the other at Olmstead, 80 miles from Williamsport, on the eastern side of the mountains.

Early in 1879 everything was in readiness for the actual work of construction. In February of that year the National Tube Works and the Reading Iron Company began shipping pipe. Because of the remoteness of the line from railways, much of it was hauled twenty to twenty-five miles over rough country where trees and underbrush had to be cut away to let teams get through. In many places a single section of the pipe 17½ ft. long, was as much of a load as a wagon could carry. To make sure that shipments of the pipe were put through promptly by the railways, it was necessary to have them accompanied by employes of the company.

The pipe laying gang had to be taught to perform the various tasks involved in stringing and joining the pipe but they evidently learned quickly and well for when the line was down it was found to be practically tight. The only trouble encountered was from the presence of wood, stones, and other obstructions that mysteriously found their way into the pipe at certain points. After acquiring a little experience, the pipeline workers were able to lay 3,000 ft. of six-inch pipe in the course of a day, or about a third as much as would be put down today by the same number of men.

Through the winter and early spring the work went on steadily and in May 1879 the last link was completed, the pumping stations had been erected and everything was ready for the test to determine whether oil could be forced through the line over the mountains. There were still many doubters. On May 28 the pumps were started. After one or two stops to remove obstructions, the system worked perfectly. Thirty-six hours after the oil was started on its journey from Coryville it was flowing into the terminal tanks at Williamsport. The problem of transporting oil was solved. The Tide Water Pipe Company, Ltd. was prepared to handle 10,000 bbl. daily through its line, giving producers an outlet to the eastward and freeing the industry from the domination of the railroads. What it meant in this respect is indicated by the fact that within a month the tank car rate from Bradford to New York was lowered from 85 cents to 30 cents per barrel. The acknowledged reason was to meet the competition of the new pipeline, but the latter still held an advantage because its costs were much below the smallest figure at which the railroads could handle the business.

Building of the pipeline had gone on during the winter and early spring. The pipe was laid on the surface and the builders neglected to make allowance for expansion. When the rays of the summer sun began beating on the exposed line, the pipe began to describe serpentine curves that carried it all over the right of way. As Mr. Benson philosophically remarked "We found we had laid altogether too much pipe." The remedy was found in placing the line underground. This brought about another problem but one that was solved in an ingenious way.

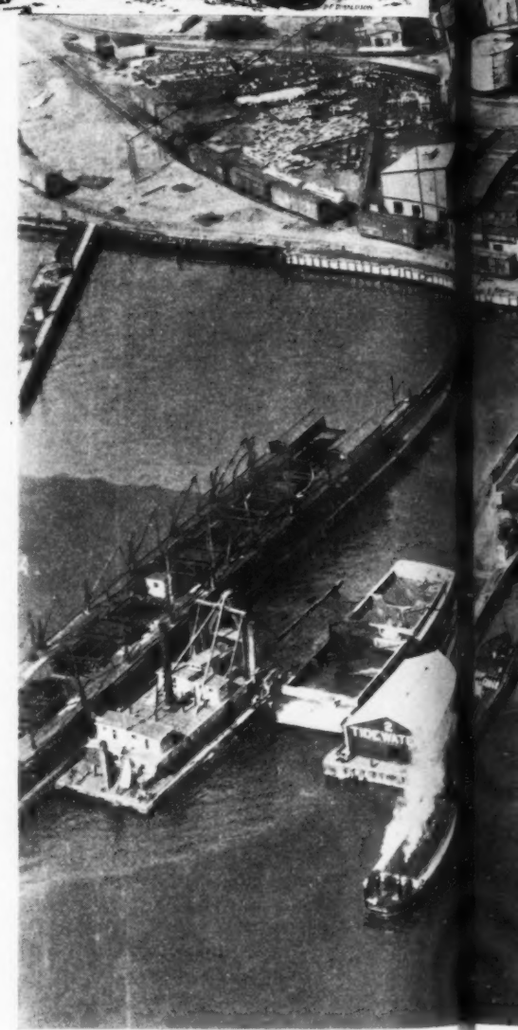
Running through the buried pipe at a temperature below that on the surface, the oil left a paraffin deposit on the inside. Chemical solutions were unsuccessful in removing this, but presently it was accomplished by stringing leather and sheet iron

washers on a long bolt that was put through the line. This was the origin of the "go-devil". The name is said to have been applied to it by farmers along the line who heard it bumping and rattling its way along inside the pipe. From its primitive form, the go-devil presently evolved to a series of revolving scrapers.

The progress of the Tide Water Line had been watched with intense interest by members of the oil industry and by none more closely than the Standard Oil Company which already had made itself the most powerful factor in the oil trade. When it was demonstrated that oil could be made to flow over mountain heights, a representative of Standard Oil offered a contract to take all the oil Tide Water could deliver at its Williamsport terminus. The Standard was prepared to take 10,000 bbl. per day which would assure operation of the pipeline at full capacity. Messrs. Benson and McKelvy must have been strongly temped to accept a proposal that would assure a profitable return on their investment, but they remembered the assistance they had received from the independent producers and declined the offer. Immediately afterward the Standard began building pipelines of its own from the Pennsylvania fields to eastern cities.

Relying upon their contract with the Reading Company, the owners of the pipeline felt confident that they would have no difficulty in selling the oil they transported to refineries in New York or Philadelphia. By the time they were ready to go into operation, however, they found that six of the seven refineries in the New York area had been bought up by the Standard group and the seventh company was not immediately available as a purchaser, being engaged in moving its plant. Having invested a large amount of capital in facilities for moving oil, they were left without means of disposing of it.

This was a contingency the builders of the pipeline had not foreseen, but they were able to meet it as they had met other problems arising before. To make their pipeline of value they had to have refineries and so they went into the refining business. In this departure, the company had valuable assistance from S. Q. Brown, a Philadelphia banker, who became the financial agent of the company, established credit with Philadelphia banks, and raised more capital with which to build refining plants.



Above, a sketch by D. F. Donaldson of the storage facilities and early refinery equipment of the Tide Water Company at Bayonne, N. J., in the days when sailing vessels carried oil exports in barrels. Right, the vast plant that has been built on the same site and to which modern additions are constantly being made to supply growing demand for Tide Water products.

Central pumping power capable of operating 14 wells of the Tide Water Associated.

Two of these were erected, one at South Chester, Pennsylvania, on the Delaware River, and the other at Bayonne, New Jersey, forerunner of the present great Tide Water refinery. The New Jersey refinery was operated by the Ocean Oil Company and a second corporation, the Polar Oil Company, was organized to produce lubricating oils and residual products, but Tide Water owned all the stock in both refineries. Later on it acquired an interest in the neighboring Bayonne plant of Lombard

Ayers & Co., and that company acted as sales agent for Tide Water products.

Most integrated oil companies begin with the ownership of production and gradually expand to include transportation, refining, and marketing. Tide Water followed a different course. True, its founders had started out as producers on a limited scale, but the company first attained an important place in the oil picture through pioneering in pipeline construction. It was compelled, by circumstances, to take the next step, into refining.

Having possessed itself of a transportation system and a couple of refining plants, the company found that it could not depend upon the oil offered to it by individual producers to keep its facilities occupied. It needed more production under its own control. Accordingly, in 1884, the Associated Producers' Company was organized under the leadership of men closely identified with Tide Water. Just as the pipeline had its inspiration in the desire to aid individual producers to reach a competitive market and to relieve them of dependence upon a single refining company or railroad, so the Associated Producers' Company was designed to be virtually a cooperative enterprise. Its organizers planned to have the ownership of its shares distributed among men who were actually engaged in producing oil and the prospectus of the company suggested that well owners subscribe

One of the modern cantilever type service stations of Tide Water Associated on Ocean Avenue in San Francisco. Note skillful architectural treatment of a two-level location.

to $50 of stock for each barrel of their daily production.

In another direction the company gave expression to a new idea—that of conservation. One of its announced objects was to save the waste and expense of drilling unnecessary wells for the protection of properties "caused by undue rivalry and competition." While many small property owners joined the organization, it soon began to acquire additional leases and properties quite in the manner of other companies. Associated Producers maintained a separate corporate existence until 1890 when all of its outstanding stock was acquired by Tide Water Oil Company which has not ceased to expand its acreage down to the present time.

While the men who started pushing the first pipeline eastward over the Alleghenies had an ocean terminal as their goal, the advance in that direction was halted temporarily at Williamsport. This was in accordance with the plan adopted when the Reading Company became interested in the project. The railroad company was to have the benefit of the freight haul from Williamsport on. The Tide Water Pipe Company agreed to pay the Reading $100,000 in case it should extend its line further east. In 1887, however, the pipeline company bought the Reading's interest in its shares, thus abrogating the contract and paving the way for completion of the line as originally projected, to tide water.

Work on this extension began immediately. In some respects it offered greater difficulties of construction than did the building of the earlier section of the line, west of Williamsport. Across the Lehigh River near Mauch Chunk, Pennsylvania, a suspension bridge 250 ft. in length was built to carry the line, the walls of rock on either side being so sheer that material had to be pulled up by ropes. Near the eastern end of the route difficulties of another kind were encountered. It was necessary to cross Newark Bay and Staten Island Sound to reach the refinery. Submarine pipe laying is a standardized operation nowadays, but at that time there were no precedents to follow.

An overhead bridge was considered but the idea was abandoned as impractical. It was decided to submerge the line and a system for doing it was worked out. This system, which, in its essentials, is still followed, consisted in loading the pipe on barges, adding joint after joint, and shoving the line back as the work progressed. The completed line was dropped overboard with barrels attached to every second length to keep the line afloat. When a thousand feet had been completed, the floats were removed and the line was allowed to sink to the bottom, being guided on its way by men working from tugs placed at intervals along the line. In this way the four miles across the waterways was constructed.

The pipeline lay on the bottom of the busy harbor where traffic was heavy. In spite of warning signs, ships' anchors caught in it, hulls scraped against it, and breaks were frequent. Repairs were difficult as they had to be made by divers. After a year, heavier pipe was put down on a new route where the water traffic was less congested. Troubles were fewer after that, but in 1899 a further change was made by dredging a four-foot trench at the bottom of the bay in which the line was placed.

Ten years after starting to push the pipeline eastward from Coryville, in the Bradford producing field, it finally reached Bayonne and the ambitious name "Tide Water" adopted by the early company was justified. By that time, however, Tide Water had become much more than a transportation system. It owned two refineries, held an interest in a third, and was a considerable producer of crude oil on its own account. It was the most important oil company in the country aside from the Standard Oil colossus built up by John D. Rockefeller and his associates.

With its eastern terminal firmly established at Bayonne, it seemed advisable to concentrate the refining activities of the company there. The plant at South

Chester was sold. Its equipment was transferred to Bayonne and the refinery there was greatly enlarged. To do this, bulkheads had to be built, a large amount of fill put in, and the salt meadows surrounding the original plant converted to solid ground. Preparatory to the expansion of its activities, a subsidiary company, Tide Water Oil Company, was organized to take charge of all refining operations. The pipeline company was still the parent and controlling corporarion and remained so until 1907. In that year, in order to simplify the structure of the organization and to reduce the size of the stock units, Tide Water Oil Company bought the stock of the pipeline and other associated companies. The company became in name, as it was in fact, a fully integrated oil company. At the same time it entered upon a new program of enlargement and expansion.

Even before this, the company, through Associated Producers, had turned its attention to the acquisition of productive areas in Oklahoma and had accumulated some 90 leases in that territory. These were transferred to the Okla Oil Company, later renamed the Tidal Oil Company, and Associated Producers turned its attention to districts less removed from the main scene of Tide Water operations.

At that time the production of the Bradford and Alleghany fields was steadily falling and was no longer sufficient to keep the pipeline working at capacity or to supply the refining needs of the company. It was, of course, still more inadequate to serve the plans for the enlarged refinery to which the company was committed. At that time, the Southern Illinois field was nearing the peak of its production. It was decided that Associated Producers should acquire acreage production in that area and that the Tide Water pipeline should be extended westward to tap that field.

This meant the laying of 550 miles of pipe for the westward extension besides adding loops and branches to the eastern portion of the system, but by this time improvements in the art of pipeline building and in the equipment employed had simplified the process. The terrain, too, was much more favorable, and the line was carried westward across Ohio and Indiana to Stoy, Illinois, with less effort and at far less cost per mile than had been represented by the construction of the earlier portion from Bradford to the east.

In 1908, therefore, Tide Water was equipped with some 900 miles of pipeline extending from southern Illinois to New York harbor. It took 19 days for the crude to travel from Stoy to the eastern terminus, but the operation was of course continuous, a barrel of oil being delivered at the refinery as each barrel was let in from the gathering lines at the western end.

It may be mentioned here that Tide Water took the initiative in another important feature of pipeline operation as it had in so many in its earlier history. This was the installation of oil engines for pumping operations. Back in 1901 the company had installed internal combustion gas engines at two of its eastern pumping stations. With the progress of development in this type of engine the shift to oil fuel was made. To complete the history of this part of the company's growth it may be added that in 1918 a second line was laid from Rixford, Pennsylvania, to Bayonne, increasing the capacity of the eastern portion of the line to 16,000 bbl. daily while in the western section 9,000 bbl. per day are handled. The whole system now consists of 1,235 miles of pipe served by 20 pumping stations housed in brick and concrete buildings and equipped with Diesel driven pumping units.

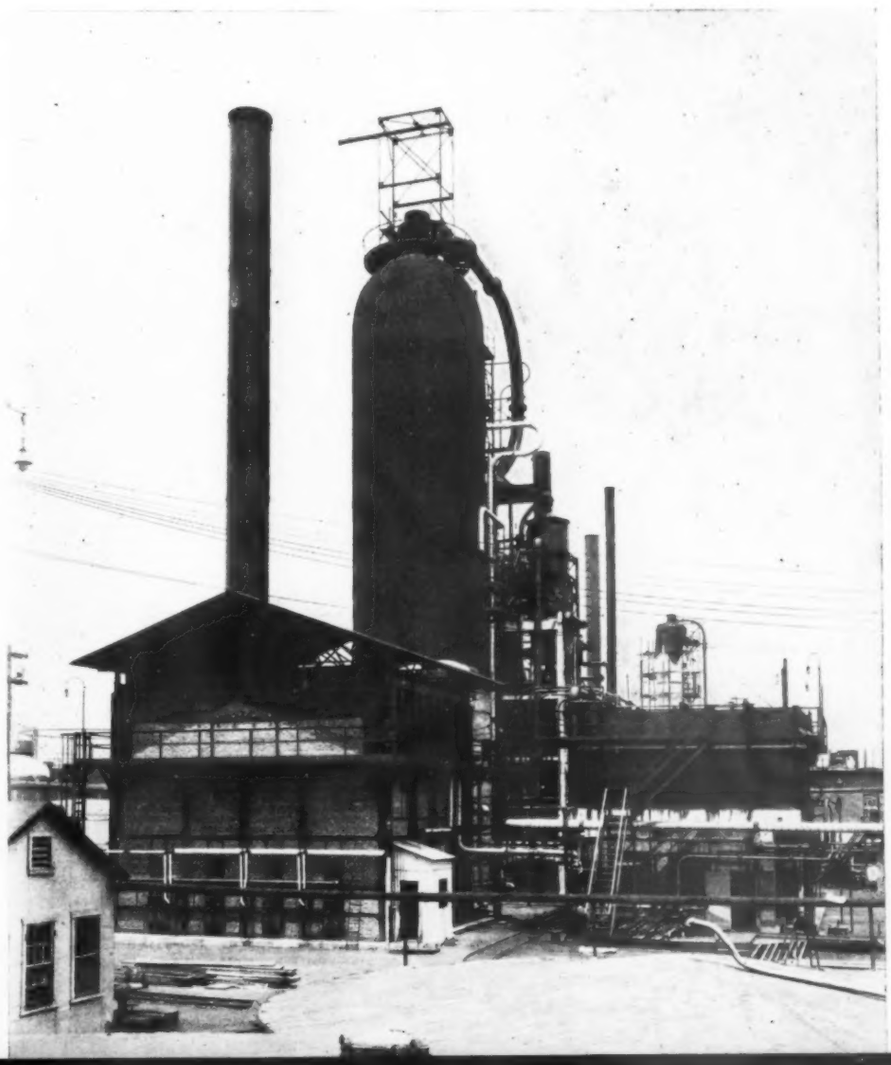
While the pipeline was being pushed westward, Associated Producers' Company added to its purchases in southern Illinois and continued to enlarge them until it became the second principal producer in that area. It also extended its operations to Kentucky and acquired extensive holdings in that state.

At the same time the Okla Oil Company, and later its successor, Tidal, was becoming more and more active in the Mid-Continent. Its early investments in the Cherokee lease, Osage area, and subsequently in the Cushing field proved very fortunate and its operations generally extended to Kansas, Arkansas, Louisiana, and Texas. At the present time, Tide Water Associated's holdings in the Mid-Continent and Gulf Coast area comprise approximately 500,000 acres.

The policy followed by Tide Water in building up its production and reserves has held true to the principles adopted by Byron Benson and his partner when they entered the oil industry by way of the lumber business—a combination of bold enterprise with cautious conservatism. Tide Water never has been conspicuous for its wild-catting activities. It has preferred to acquire holdings in proven or partially proven areas, but it never has waited for such lands to become too expensive for profitable operation before stepping in. Its success in following this program has been so great that whenever the company enters a new area it is taken for granted by oil men long in the business that that field is assured of profitable production.

In the early years of the century, when Tide Water was undergoing a rapid expansion, the oil industry itself was being transformed. The world, and in particular the United States, was being motorized. Demand for gasoline and lubricating oil was growing by leaps and bounds and kerosene was falling into the background. Tide Water equipped its Bayonne plant

Single flash distilling unit with capacity to process 9,250 bbl. per day of 24 deg. A.P.I. gravity reduced mid-continent crude designed and erected by Foster Wheeler for Tide Water Associated's Bayonne, N. J., refinery.



to meet this change, acquired rail and lighterage equipment, organized a cooperage division—the Tide Water Hardwood Company—built a case and can shop, and otherwise prepared to meet the growth in business that was immediately in sight. As yet, however, its sales were handled in bulk lots. Much of the output went into the export trade though not under a distinctive brand name. It was not until 1913 that the company entered the field of retail marketing.

By that time the excellence of Tide Water products was widely recognized in the trade and it seemed wise to capitalize this reputation and build up a sustained demand among consumers. The engineering department of the company had just perfected a new and superior oil for lubricating internal combustion engines. To this the name Veedol was given and a sales and advertising campaign was started to acquaint the public with its advantages. It was followed shortly by Tydol Economy gasoline. At first, sales were handled through the Platt and Washburn Refining Company, a subsidiary, but at the end of 1917 that company was dissolved and thereafter sales were handled directly by the main company. In 1919 a special Export Department was organized to handle business abroad which has since been extended to every part of the world.

For the most part Tide Water has developed its crude production within the United States but in 1920 the necessity of providing additional supplies for the Bayonne refinery led it to invest in Mexico through the Tidemex Company and to build tankers for transporting the Mexican crude to New York harbor. When the output of the Mexican fields fell off the company went further afield, to California, to secure its supplies and for several years brought large quantities of crude oil from the Pacific Coast via the Panama Canal.

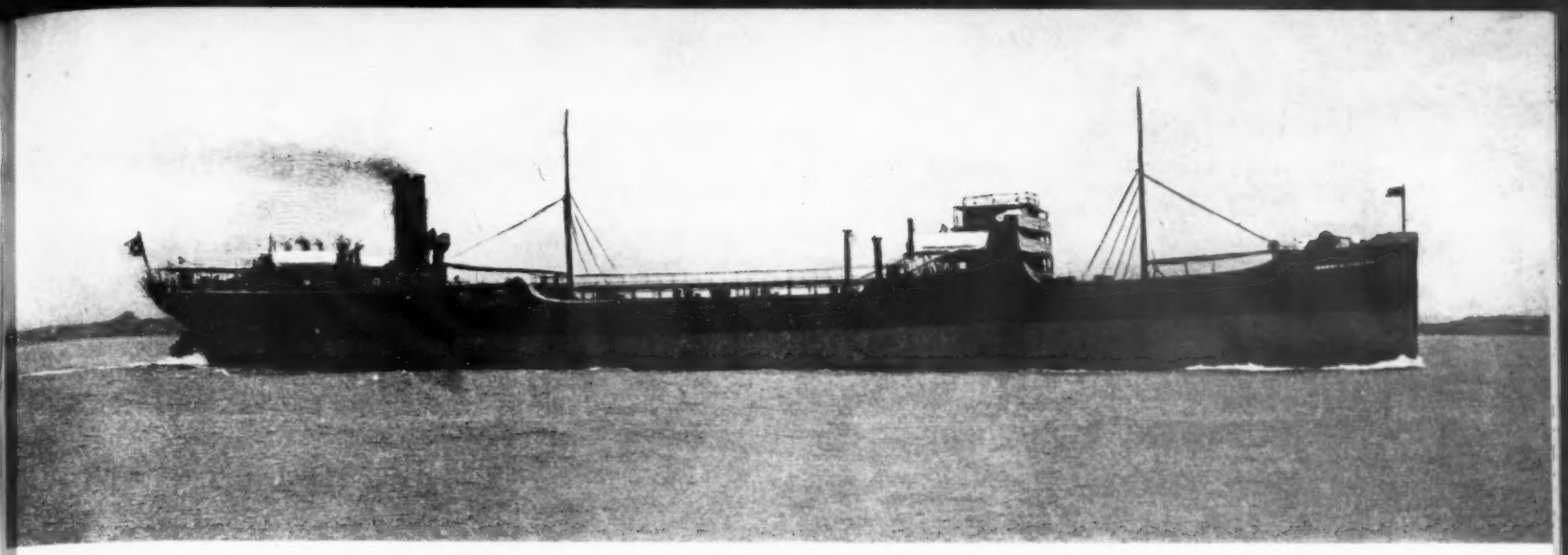
As the business of the company has grown the refinery at Bayonne has been reconstructed and enlarged. Its present capacity is 60,000 bbl. daily. A second refinery at Drumright, Oklahoma, has a capacity of 12,000 bbl. per day. In 1932 Tide Water led the way in the production of high octane gasoline by adding a 6,000 bbl. Tube and Tank cracking unit at Bayonne, and recent additions have kept the plant in the foremost rank among refineries.

BIRTH OF ASSOCIATED

In 1901, when Tide Water Oil Company was growing apace as a producer and refiner in the East, another company came into existence in California under circumstances similar to those attending the origin of Tide Water. Early in that year oil had been discovered in the Kern River Section of the San Joaquin Valley when J. M. Elwood, in drilling a water well, found oil in paying quantities at a depth of 75 ft. It was shallow production, inexpensive to develop, and consequent y started such a rush of drilling that within a short time the state's production tripled. Prices fell to 25, 15 and even 10 cents a barrel. Such demand as existed was for fuel oil though few industrialists at that time were convinced that it offered advantages over coal. Transportation was lacking and there were no nearby refineries to convert the crude oil into other marketable products.

Nevertheless, the possibility for profit appeared attractive and with another new field being developed at McKittrick on the west side of the San Joaquin Valley, several oil men saw an advantage in joining forces. The group included C. A. Canfield and J. A. Chans'or, former go'd miners who had been associated with Edward L. Doheny, a man later famous for h's own achievements in the oil industry. These two had discovered light crude oil at Coalinga, California, in 1895 and were prosper-

Marine terminal of Tide Water Associated Oil Company, at Revere, Mass., from which products are distributed in the Boston area.



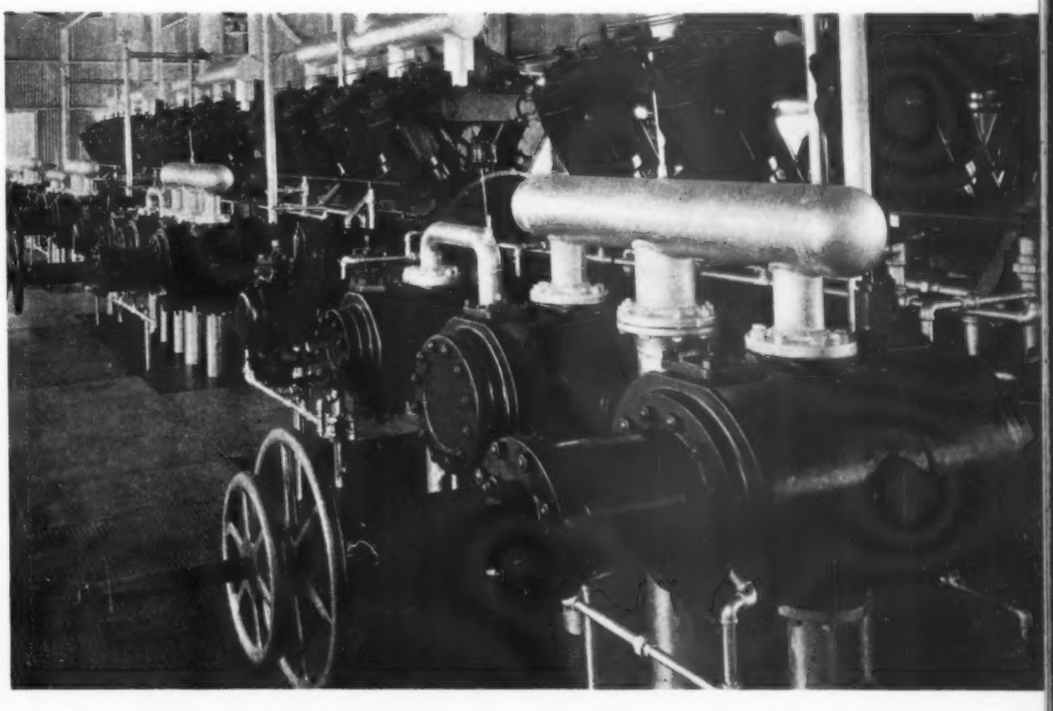
Tankers of the Tide Water Associated fleet carry petroleum produced from the United States to the four corners of the world.

ing. Others in the group were Max Whittier and Burton E. Green, veterans of four or five years in the Salt Lake oil field at Los Angeles, and partners in a venture on Kern River. Green is still active in the oil business. He is president of one of the larger independent producing companies in California—a company which has had friendly business relations with Associated for many years past. Other pioneers were H. M. Reed, holder of extensive orchards at Reedley, California, W. F. Chandler, a vineyardist from Fresno, B. F. Brooks and M. J. Laymance, real estate men from San Francisco and Oakland, Othello Scribner and Henry Ach, lawyers from Fresno and San Francisco, W. S. Porter, a pipe salesman for J D. Hooker & Co., a supply house, and John A. Bunting, formerly a railroad conductor on the Southern Pacific Railroad. All were interested in Kern River oil land and many had holdings at McKittrick. Their properties ranged from a whole section of six hundred and forty acres down to ten acre plots.

Porter, the pipe salesman, was forceful and ingenious. If he could get these men together he should be able to sell the pipe for the line that would carry their Kern River production down to a relatively stable market at seaboard. Note the parallel here with the impetus behind the earlier formation of Tide Water in Pennsylvania. Porter urged the group to pool their producing interests. In furtherance of his plan, he interested A. F. L. Bell, a consulting engineer who had been trying to develop a market in the East and in Europe for California asphalt; William Mulholland, discoverer of oil in Santa Barbara County; and Bernard Benfield, consulting engineer for the Southern Pacific. A number of small operators whose names were later to loom large in California oil history were induced to invest.

It can be seen that substantial oil experience characterized this group. Canfield and Chanslor, for instance, owned five wells and already were men of financial substance though they still paid close attention to the details of their business. A veteran oil man, then a youngster in the business, tells of meeting Charlie Canfield in the field dressed in faded blue jeans and of going with him from one well to another while he inspected them to see that they were pumping properly. Asked why he was doing such ordinary work he replied: "Young man, this is my business and I want to know what's going on. If you ever have a business of your own, make it your job to know its every detail. Then it won't be easy for someone to fool you." Those were great days and developed many men whose names the industry should not let pass into oblivion. It is unfortunate to dismiss so colorful a character as Charlie Canfield in one paragraph. Space here permits but one more passing recollection. Chanslor and Canfield had entered partnership, and after drilling some wells in the Los Angeles Field, shipped their outfit to Coalinga, where Canfield loaded it on a four-horse wagon and started back into the hills to wildcat. A few miles from town the wagon sunk and stalled in an alkali dry-bog. After working some time without success to get it free, Canfield said, "Hell! This is just as good a place to drill as any," and in picturesque contrast to the pains aking geological work and artificial "earthquakes" of today, the old "fiddle rig" was unloaded and put to work there by the side of the road. Four hundred feet down a 25-bbl. flowing well came in. Thus was California's "Oil City" field discovered.

Max Whittier was a field worker who had acquired Kern River acreage and brought in some good wells. Besides being a man of great business ability, he was of a mechanical turn of mind and originated the rotary tool joint.



Compressors in a pumping station on a Tide Water Associated pipeline in California.

Carneras pump station in 1914.

Such was the calibre of the men who had got together to establish a company that was destined to fill a great place in the industry.

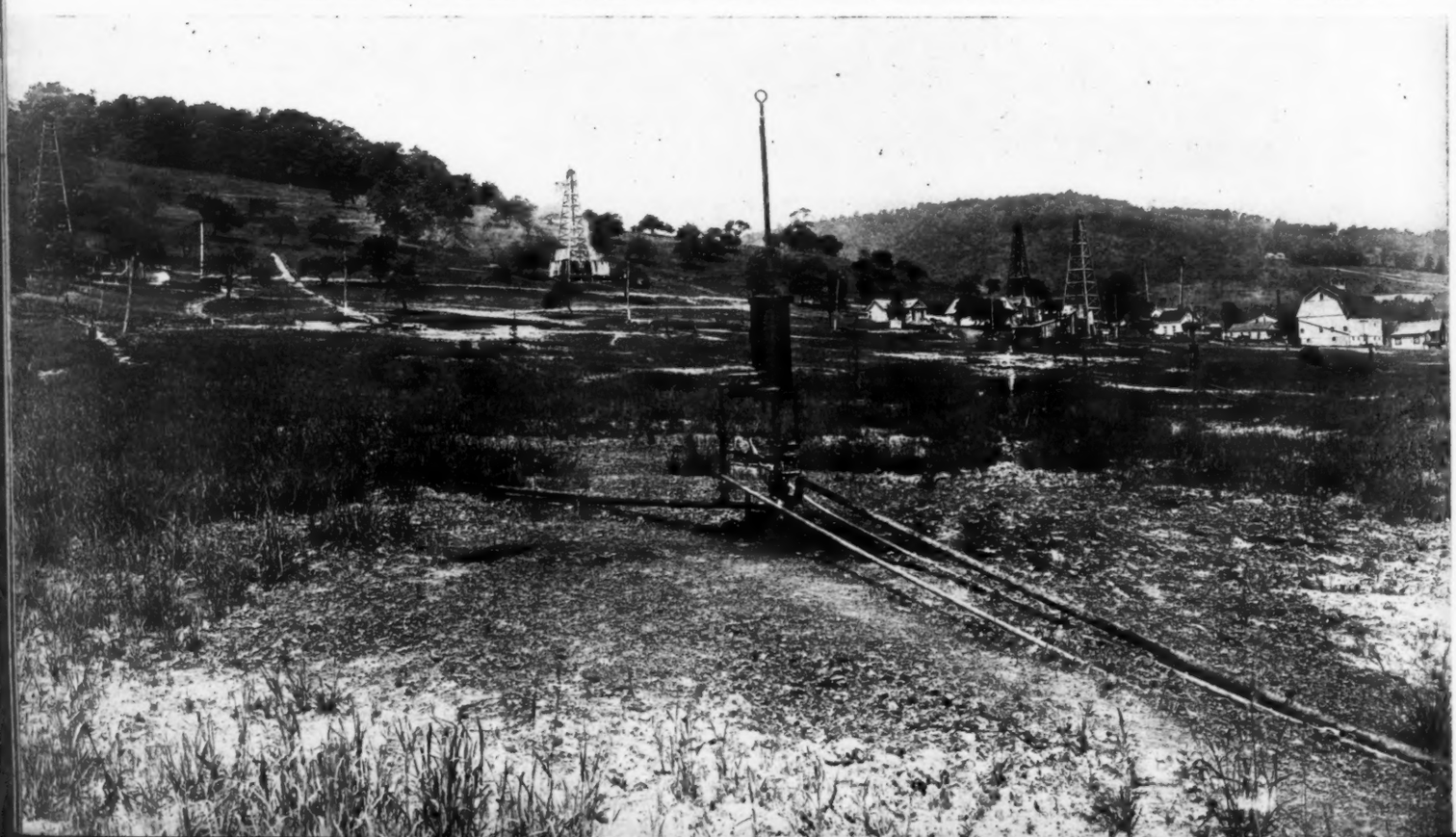
In October, 1901, they incorporated as the Associated Oil Company. Canfield was chosen president and the pipe salesman, Porter, general manager. At the outset, the company absorbed properties of five small producing companies. A year later it had expanded to embrace nearly 40. While the founders of the corporation may have been short of ready cash, there was nothing small about their ideas and Associated was authorized to issue $40,000,000 of common capital stock.

In the interests of an equitable arrangement, two geologists, Bernard Benfield and Arthur F. L. Bell, were employed to map the properties. Three zones of production were established; first, an "A" zone in the center of the field; second, a "B" zone, comprising a strip around the "A" zone; and, third, a "C" zone which comprised edge production. Holdings were appraised and an upset price put on the properties in each zone. Payment was offered in stock and bonds. Stock was used in paying for land holdings, and bonds were used in paying for buildings, completed wells, tankage, tools, and pipe.

Henry Ach, a San Francisco attorney who also managed the Monte Cristo Oil Company, handled legal matters for the new company and Othello Scribner kept the records.

Of greater importance at this time than the formal organization was the establishment of a trust agreement, which involved the issuance of trust certificates in lieu of stock and the pooling of voting power of the stock in a group of eleven men. These included, in addition to the company's officers, W. F. Chandler, John A. Bunting, B. F. Brooks, W. A. Jacobs, and Frank H. Buck. Buck, a ranch owner at Vacaville, and Alden Anderson, a banker at Sacramento, had been heavily interested in a number of small Kern River companies and were among the first to join in forming Associated. The trust agreement was for a term of 20 years from February 28, 1902, but was dissolved in January, 1910.

Five-Spotting: four wells drilled in a square around a center well, water forced into the four wells at about 900 lbs. pressure flooding the oil sands and forcing oil out of the fifth well in the center, greatly increasing production around Bradford, Pennsylvania.



Nearly 40 independent producers in the Kern River and McKittrick fields accepted stock and bonds for their holdings and became part owners of the Associated Oil Companies. These properties are still held by Associated. Stock was issued amounting to $39,765,085, and this continued to be the basis of the corporate structure until 1919. As the purchase of improvements did not require issuance of all the bonds, some were sold to realize working capital. Others were issued and pledged as security for loans.

While the founders of Associated were devoting their efforts to the production of crude oil at Kern River and McKittrick, the Matson interests, owners of a marine transport line and investments in Hawaii, were laying plans for the transportation and sale of California petroleum.

Matson's Pacific Oil & Transportation Company was organized with small capital to market fuel oil. Operations grew and the National Oil & Transportation Company was organized in 1903. In 1904 it built a six-inch pipe line from Coalinga to Monterey Bay through which light oil was pumped to tide water and loaded aboard tankers of the Matson Navigation Company. This was the first oil pipe line in California. Many years later it was extended to the Belridge Field, and today is used to convey gasoline to Monterey.

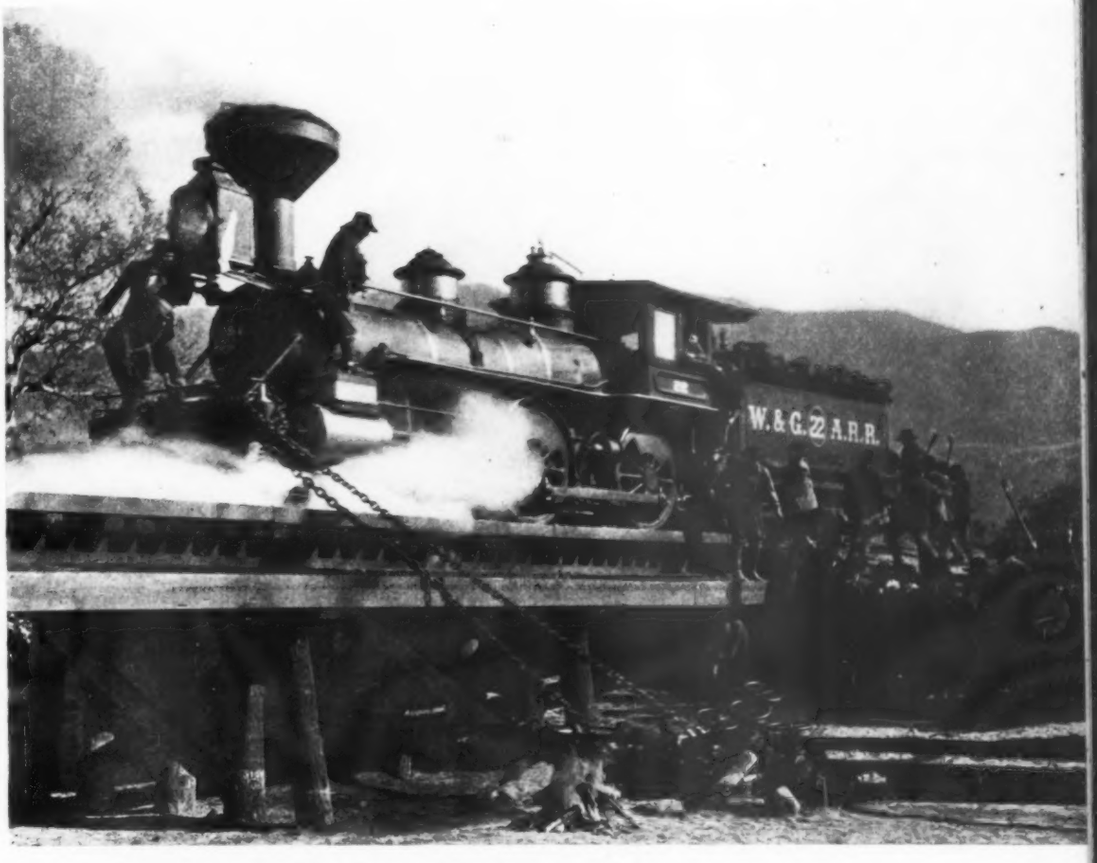
Oil was discovered in the vicinity of Santa Maria in 1903 and 1904. It was heavy oil but it could be utilized as asphalt and road oil if a means of transporting it by pipelines could be found. Finally a plan was devised to handle the oil by mixing it with distillate. The J. D. Hooker interests joined with Matson's Pacific Oil Transportation Company in 1903 and formed the California Coast Oil Company, incorporated for $200,000. This company built a pipeline from a refinery at Gaviota to the field, equipped for two-way pumping. Distillate was first pumped to the field and mixed with the heavy crude. The crude and distillate mixture was then pumped back to the refinery at Gaviota. There it was heated, the distillate recovered by condensation, and the asphalt barreled for shipment.

In 1905 Associated Oil Company, faced with the problem of establishing adequate pipeline outlets, acquired the Matson Steamship's interest in the latter's oil projects, including the Coalinga-Monterey pipeline and the refinery at Gaviota. George Cameron, today publisher of the San Francisco Chronicle, was secretary of the corporations purchased from the Matson Company. In speaking of this deal in later years, Cameron said: "I remember that at the final meeting when I presented a memo setting forth the details of the deal there were present with the Associated representatives, E. C. Calvin and Peter Dunn, officials of the Southern Pacific whose authorization to purchase was apparently necessary."

Rapid expansion had proved a tax on working capital and Associated gave notes for the Matson properties secured by bonds and trust certificates. Walter E. Buck whose father was an associate of William Matson and George Cameron, and who represented the Crocker Bank in its relations with the Matson Company, continued to look after the properties until the notes were paid. Buck, at San Francisco, was in charge of marine equipment, and Cameron was in charge at Bakersfield.

Terminal facilities involved in the deal included marine loading stations at the foot of Second Street in San Francisco and at Alameda Point across the Estuary from Oakland. Floating equipment included the S.S. W. S. PORTER of 7,000 tons cargo capacity, S.S. ROSECRANS, 5,000 tons, and the sailing tankers, FALLS OF CLYDE, and MARION CHILCOTT; also three tow barges converted from sailing vessels into petroleum carriers, the MONTEREY, RHODERIC DHU, and SANTIAGO.

While eastern railroads fought the building of Tide Water Oil Company's early pipelines, the Southern Pacific Railroad not only co-operated with Associated, but rendered valuable financial aid in the construction of its pipelines. The railroad owned alternate sections of land, except school lands, for various distances on each side of the railroad company's right of way—grants from the Federal Government. Kern River Field was within this area. Most of it was practically desert land and supposedly of little or no value. When J. Elwood and his brother found oil in an outcrop in June 1899, the land department of the railroad seized the opportunity to sell as much as possible of its Kern River holdings at $2.50 per acre. By granting easy terms, a down payment of 50 cents an acre, it sold nearly all of its land in this district and also at McKittrick. This was the price paid for properties by most of the pioneer oil men who later founded Associated Oil Company or who sold out to Associated in 1901. Before long these land values had increased to $5,000 per acre and more.

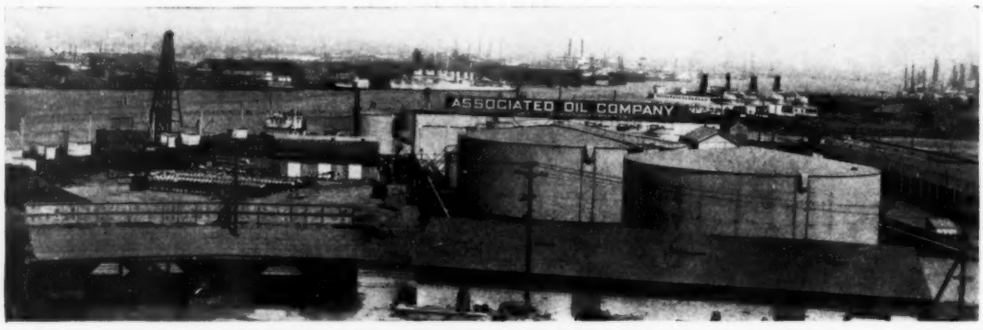


From the motion picture "High, Wide and Handsome" recently released by Paramount comes a scene of early fights between railroads and pipelines. Fearing loss of important traffic from the oil fields, railroads attempted to prevent the operation of pipelines by tearing them up where they crossed the railroad's right of way.

The growing use of fuel oil in railroad engines was an important factor in the early development of Associated Oil Company. Oil had first been used as locomotive fuel in Southern California by the Santa Fe Railroad just prior to the development of the Kern River Field. K. S. Wade who had been brought to California from Illinois in the late '90's to become General Manager for the Santa Fe at Los

Angeles, had been accustomed to paying $2.50 per ton for coal in the Midwest. When he found that, in California, his company had been paying $9 a ton for Australian coal delivered at San Pedro, he and his chief clerk, Fred B. Henderson, determined to seek other and less costly fuel. They found it in the oil then produced on a small scale in the Los Angeles Basin. A long series of experiments resulted in its adoption. Incidentally, world-wide inquiry by Wade failed to find any instance where oil had previously been used as locomotive fuel. Thus he and Henderson, to whom much credit is also due, pioneered the way for new and vast markets for oil just before the Associated Oil Company came upon the scene. Henderson later went to work for Associated, a connection which lasted until his death in 1929 when he was a director and vice president of the company.

Chanslor and Canfield had taken a contract to supply the Santa Fe with fuel oil and when they both became interested in Associated, they purchased their supply for the railroad from the new company.



Tide Water Associated bulk distributing station at Alameda, across the Bay from San Francisco.

Southern Pacific, knowing all about what Santa Fe was doing, sought a supply of fuel oil for itself, and found it in the new Kern River field. Associated captured this business and so from the beginning, the Southern Pacific was the Associated Oil Company's largest customer.

It was not long before the railroad began to buy Associated Oil trust certificates, heretofore mentioned. Its first important purchase, according to present-day report, was the interest of C. A. Canfield who did not always see eye to eye with his associates and after some difference of opinion, withdrew from active participation in the new company. He resigned as president in June, 1902, and was succeeded by his former partner, Chanslor, who had been elected a director in December, 1901, to succeed M. J. Laymance. Today, 35 years later, Chanslor is on the directorate of Tide Water Associated Oil Company.

Other changes in personnel occurred in 1904 when W. S. Porter, general manager, was elected first vice president; W. F. Chandler, second vice president, and Othello Scribner, assistant general manager and secretary. Secretarial work increased and in 1905, W. A. Sloan was elected assistant secretary.

Associated Oil Company early began to secure additional production through purchase of all interest, or a controlling interest in other companies. Important among these acquisitions was the Salt Lake Oil Company, which had been formed by J. E. Koeberle and W. C. Price of Los Angeles, together with Salt Lake City capital headed by Jake Bamberger. Its holdings were just west of the then city limits of Los Angeles on part of the Hancock ranch. A number of large wells had been brought in and a new field opened, to which Salt Lake Oil Company's name was given. Associated acquired control of the company in 1904 and placed title and management in the hands of a new $5,000,000 subsidiary, the Amalgamated Oil Company. Temporarily, Price remained as president and manager, but soon resigned and disposed of his remaining interest in the property. Fred B. Henderson, who after leaving the Santa Fe Railroad, had been in charge of the Associated's Kern River properties, was transferred to Los Angeles to take over the management. Amalgamated pushed an aggressive campaign of development in the Salt Lake Field and acquired other properties in Southern California, principally in the Brea-Olinda (Fullerton) and East Coyote fields. A 5,000-bbl. topping plant was erected in Los Angeles to process the newly acquired production. Lighter fractions were sold to local refineries for manufacture into gasoline and other marketable products. Amalgamated's own marketing operations were confined chiefly to fuel oil. By aggressive salesmanship, the company almost immediately captured a large share of the Southern California fuel oil trade. Eventually, Amalgamated was completely merged with the parent company, Associated Oil.

In 1907, with financial backing from the Southern Pacific Railroad, the Associated Pipe Line Company was organized as a subsidiary of the Associated Oil Company and began construction of a pipeline from Kern River to San Francisco Bay. This line, nearly 300 miles long, was completed in 1908. It had a capacity of 25,000 bbl. daily and provided economical transportation from the Kern River Field to Port Costa and to Avon where later a great refinery was to be built.

Southern Pacific, already a factor in San Joaquin Valley oil development, was increasing its interest while these events were transpiring. It had organized the Kern Trading and Oil Company which took over the remaining Southern Pacific acreage at Kern River and trust certificates for Associated Oil Company stock purchased up to that time. A Californian named Speed conceived a method of transporting oil by pipeline based on pumping a thin layer of water along the walls of rifled pipe to accelerate movement of the oil. The railroad thought enough of the idea to build 24 miles of 8-inch line (north from Bakersfield). Experimental runs proved satisfactory and in 1907 the newly formed Associated Pipe Line Company extended the 8-inch line to Port Costa on upper San Francisco Bay. The line was financed by E. H. Harriman, at that time in control of the Southern Pacific. The 300-mile line was completed and put into operation in September, 1908.

As originally built this rifled pipeline system included a pumping station every 24 miles, each station being equipped with large steam pumps to handle the oil and smaller pumps to force the coating of water into the rifling. The ratio of liquids forced into the line at the intake was 15 percent water and 85 percent oil. The system worked well as long as the oil from the wells was comparatively free from water, but as the water content increased an emulsion was caused from which the water would not settle. The water introduced into the line combined with the water in the wet oil and the entire content of the line became emulsified, thereby defeating the principle of the rifled line.

Subsequent experiments in heating the oil proved it could be pumped hot without the addition of water, though this method necessitated additional pumping stations between those already installed. A. M. Benfield, brother of the geologist, who with Bell had mapped productive oil lands at Kern River and McKittrick, was chief engineer on this pipeline. A year or two later a second line was built for transporting crude oil from the west side fields to Port Costa and nearby points.

By 1909, Associated had expended over $61,000,000 for lands, pipelines, marine equipment, improvements, and stock in other companies. Crude oil production had been successfully developed in the Kern, McKittrick, Coalinga, Salt Lake, and the Whittier-Fullerton areas.

Lack of working capital continued to be a serious problem even at this time when the Associated was supplying all of the fuel used by the Southern Pacific.

After considerable discussion of ways and means of solving such problems, an agreement was reached during 1909 under which the Southern Pacific acquired 51 percent of the common stock of Associated. The consideration was $20,069,000. The

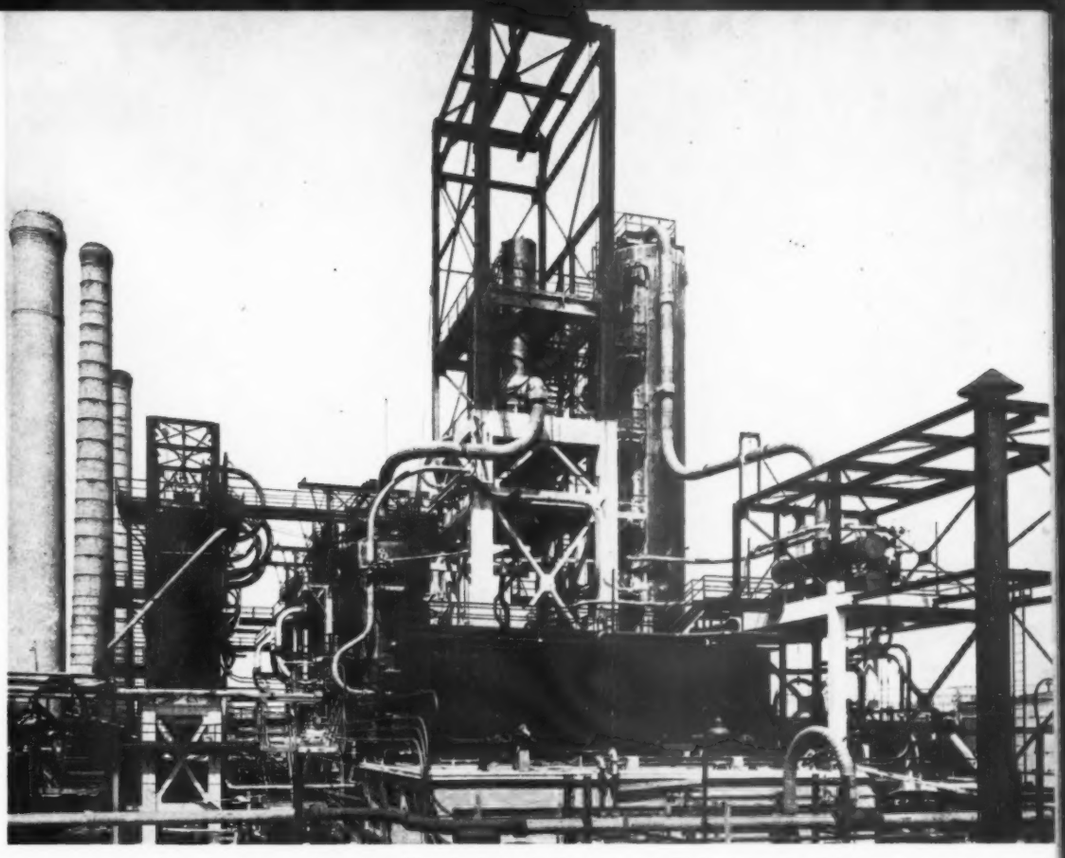
voting trust agreement in existence from the time of the organization of the oil company was then terminated, and stock was issued to holders of trustee certificates. These negotiations with the Southern Pacific were completed February 9, 1910, when J. A. Chanslor resigned as president to be succeeded by William F. Herrin, vice president of the Southern Pacific Railroad. Chanslor remained as director, and on February 28th he was elected a vice president of Associated. Paul Shoup of the Southern Pacific was also elected a director and vice president. Shoup resigned as vice president January 17, 1911, and was succeeded by Othello Scribner, who had resigned as secretary September 13, 1910, during the negotiations for sale of control. Shoup continued as a director and was elected president of Associated in 1918. Herrin found that his work with both railroad and oil company was too much of a burden so he resigned as president of Associated on April 30, 1912, and was succeeded by William Sproul.

The company's aggressive acquisition of producing properties continued and in 1910 it purchased a three-quarter interest in Section 30 in the Midway field from a San Franciscan, I. Strassburger, who had brought in a 10,000 bbl. gusher on the property. Two weeks later he accepted Associated's offer of $1,450,000 for the three-quarter interest. The Pioneer Midway Oil Company Consolidated was formed as an affiliate of Associated, with the latter holding 75 percent and Strassburger 25 percent. This deal was arranged by Frank Buck, C. J. Kirkpatrick, and Othello Scribner.

By 1912 Associated Oil Company's annual gross revenues had exceeded $16,000,000.

With pipeline facilities capable of delivering 14,000 bbl. of oil a day at Monterey Bay and 60,000 bbl. daily at Port Costa, attention was turned to the construction of refineries. Chemists had devised efficient methods of extracting gasoline and kerosene from California crude oil, and there was a growing market for distillate. Fuel oil sales continued to increase spurred by a 180 deg. flash test for marine fuel oil. Burning crude just as produced had been found dangerous. To meet these requirements and provide other refined products for a growing market, Associated Oil Company commenced construction of a refinery at Avon on San Francisco Bay in January, 1913. The original plant cost $750,000.

Associated Division emblem on western retail stations.



Tube and Tank cracking unit designed and installed by the Lummus Company at Tide Water Associated's huge Bayonne, N. J., refinery.

Marine facilities were augmented during 1914 by the construction of the tanker FRANK H. BUCK, with a capacity of 62,000 bbl. This tanker continued in service until March, 1937, when it was lost at San Francisco's Golden Gate, following collision with the s.s. PRESIDENT COOLIDGE.

Although increasing amounts of crude oil were refined, it is noted in government reports that during these years and even through 1918 and 1919, about 70 percent of California crude was sold as fuel oil and during the latter years 7 percent more was exported. To meet increased requirements during the war, additions and improvements were being added to refining facilities and operations were expanded with the discovery of new fields.

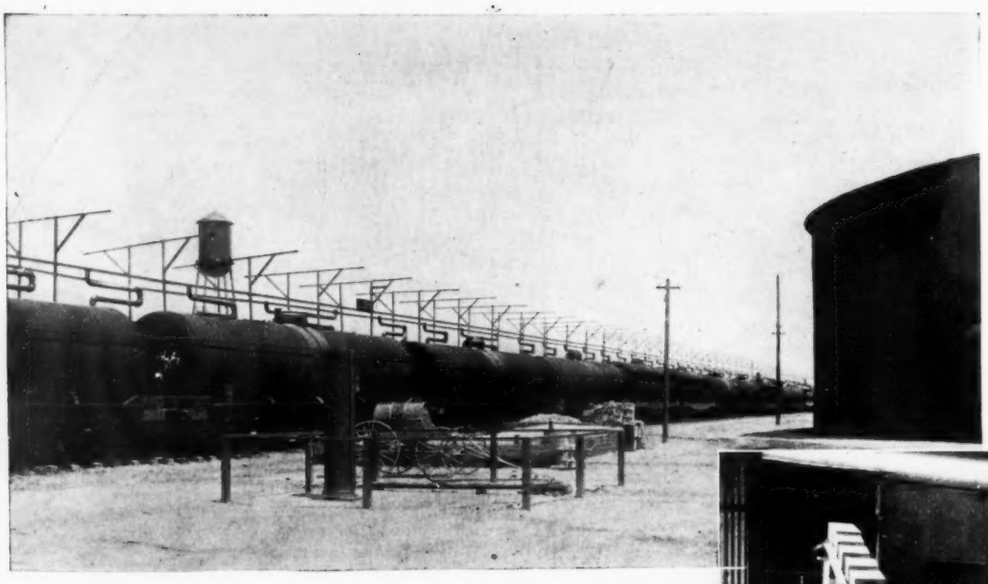
Up to 1913 Associated, as has been shown, had manufactured and marketed fuel oils almost exclusively. With the completion of the Avon refinery, today recognized as one of the most modern and efficient in the United States, the company launched into the manufacture of gasoline and kerosene and besides selling these products locally, began to develop a large market in the Orient. Years later, with the installation of additional equipment at Avon, motor oils and greases were manufactured.

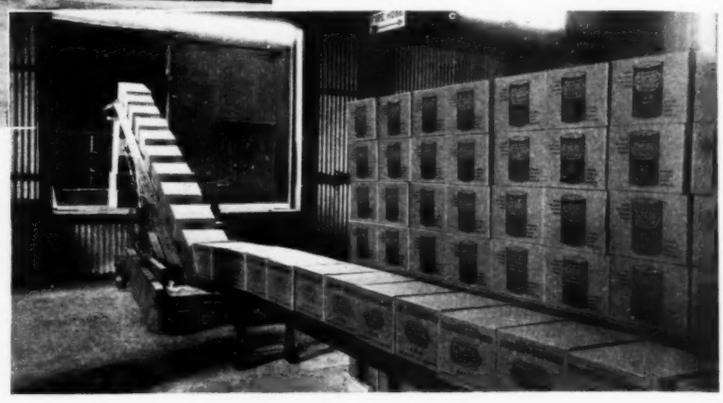
Naturally a substantial increase in the sales force occurred during these years. In 1915, the company established its first service station, located in San Francisco.

The Southern Pacific continued to be an important influence in Associated's development. The railroad, which had acquired a controlling interest in the oil company in 1909, for the next eleven years continued to maintain that control. In 1920, however, Paul Shoup and his fellow directors of Southern Pacific decided to separate the railroad's oil interests, including its stock interest in Associated, from its other properties, and the Pacific Oil Company was formed in 1920, for the purpose of acquiring such assets. Pacific Oil Company held a majority interest in Associated Oil until 1926 when Pacific Oil sold its oil properties to Standard of California. However, the Associated stock which Pacific Oil held was not included in the deal in view of the competitive position of Standard and Associated. Announcement came out of New York in February, 1926, that the stock had been purchased by Blair & Co., and Chase Securities Corporation at $59 a share.

In March, 1926, a consolidation of major importance took place. This was accomplished through the organization of the Tide Water Associated Oil Company which acquired control of the long established Tide Water Oil Company in the East and the Associated Oil Company in the West. Tide Water Associated was a holding company, its two constituents retaining their corporate entity and continuing under separate managements.

As has been pointed out, there were





Tracy, California, loading rack of Tide Water Associated above; right, Cycol, solvent refined oil of Associated, being conveyed into freight cars for distribution on the Pacific Coast. Associated was one of the first companies to experiment with solvent refining, beginning its work on this process in 1926.

striking similarities in the histories of the two companies thus brought together. Tide Water started out as an undertaking to enable independent producers to reach markets from which they were virtually cut off. The same was true of Associated in California at a later date. Tide Water made itself a factor in the eastern situation through construction of a trunk pipeline. Associated's early success was achieved in a similar way. Both had grown from small beginnings to become fully integrated companies engaged in production, transportation, refining, and marketing. Being situated on opposite sides of the continent, each complemented the other, resulting in a company whose operations extended to all parts of the country as well as throughout the foreign field.

While Tide Water had been responsible for many innovations in the oil industry in the course of its history, Associated, in its own field, had accumulated an impressive list of accomplishments to its credit. One of its outstanding achievements has been the discovery and development of the Ventura Avenue Field. It discovered the East Coyote Field, completed Butterworth No. 1 at Santa Fe Springs in 1921 at a depth of 4,682 ft. as the then deepest producing well in California, completed Green No. 2 at Santa Fe Springs in 1923 for 13,835 bbl. as the largest producing well in Southern California brought in under complete control, made a record recovery on a 17½-acre parcel at Santa Fe Springs of 613,273 bbl. per acre, and discovered in 1929 the Clarke zone at Santa Fe Springs in Clarke No. 2 at 8,165 ft., the well being cemented at the record depth of 7,802 ft. with five-inch casing and taking the record as the deepest producing well in California at that time.

Earlier, in 1922, Miley-Keck No. 19 at Huntington Beach was completed at 4,942 ft. for 2,563 bbl. as the deepest producing well in California at the time. At Huntington Beach, Associated obtained the largest oil recovery in the field on a parcel of 7½ acres, at the rate of 578,495 bbl. per acre. In 1924, Associated completed DeFrancis No. 3 in the Dominguez field at a depth of 4,277 ft. for 6,037 bbl. as the largest producing well completed in the Dominguez field.

The company's production record at Ventura Avenue has kept pace with its excellent drilling performances. From late 1922 through 1936, twenty-nine wells drilled on its properties have each made over 1,000,000 bbl. of oil. One of these produced in excess of 2,500,000 bbl., two in excess of 2,000,000 and eight in excess of 1,500,000 bbl.

Prospecting had been going on for several years in this field with rather negative results prior to the entrance of Associated in the field and the completion of its Lloyd No. 5 in October, 1922. This well bottomed at 4,051 ft. with an initial production of 2,100 bbl., which conclusively proved for the first time the commercial potentialities of the field. On completion of its Lloyd 9-A on January 27, 1925, at a depth of 5,150 ft. for 4,555 bbl., Associated demonstrated the production of deeper oil measures that have proved the main source of production in this field. The company further contributed to the development of Ventura Avenue by the discovery of the deep so-called "57 Zone" in its Lloyd No. 57. This well was completed on April 28, 1931, at a depth of 8,823 ft. with an initial production of 5,282 bbl. Lloyd No. 57 not only discovered a new zone, but set a world record for the deepest commercial producer.

A little more than a year later, No. 57 lost its world record to Lloyd No. 83 Associated well in the Ventura field. This well was completed at a depth of 9,710 ft. with an initial production of 5,547 bbl. and a total output to date in excess of 2,500,000 bbl. No. 83 held the world's record for depth until the completion of Lloyd No. 131, which was completed at 9,846 ft. on August 3, 1935 with an initial production of 2,285 bbl. Lloyd No. 131 continued to hold the record until the completion of the Rigolets Fur Company No. 5 in the La Fitte Field, Louisiana. This well was bottomed at 10,244 ft. During the early days of 1937, however, Associated regained the record by completing the famous McGonigle No. 12 flowing 536 bbl. daily of 30.3 gravity oil from 10,569 ft. While a number of California wells have been drilled to a depth of over 10,000 ft., this was the first to rank as a really successful producer. It is located in the Ventura Avenue Field and offered unusual difficulties in drilling due to the fact that it is on the flank of a sharp anticline. Nevertheless, the drillers were able to sink a practically straight hole to this great depth, the greatest deviation from the vertical being no more than three degrees. Another remarkable record was made in cementing the hole to 6,215 ft. in an hour and fourteen minutes. The significance of McGonigle No. 12 was that it demonstrated the soundness of the belief that production can be developed in certain California fields at deeper levels than have been reached heretofore.

The first solvent refining unit utilizing the Edeleanu process in America was installed at the Avon refinery. The installation was first provided for the manufacture of kerosene, but has since been improved and enlarged so as to produce also high grade lubricating and transformer oils.

The Avon refinery manufactures lubricating oils, greases, and asphalt, as well as the usual products of gasoline, kerosene, gas and Diesel oil, and fuel oils produced from the distillation and cracking processes. Complete packaging facilities are also available. The bulk of the products are shipped by water over the company's

wharves, the remainder being shipped by rail and truck.

The company also has a refinery at Watson in the Los Angeles district, with light crude distillation capacity of 10,000 bbl. daily. In addition, this plant has facilities for the viscosity breaking of residuum to the extent of 7,500 bbl. daily. The primary function of the plant is to supply gasoline and fuel oil requirements in Southern California.

In marketing its products, Associated has operated through independent retail dealers as well as through company owned stations. From the beginning it has recognized the importance of dealer cooperation, uniformity of facilities, and a public demand for Associated products. Of these objectives, the first two have been attained by a carefully planned system of dealer merchandising, education, and the third by original and well directed advertising campaigns.

In its advertising, Associated has impressed upon the public simple, specific points in connection with the many developments in its service. One of its great successes has been its radio sportcasts of football games and other sport activities which have been carried on for over ten years and have established an intimate, friendly relationship with the sport loving public. The results of its merchandising and advertising activities are reflected in a constantly growing volume of sales throughout its territory.

Associated has operated in countries in the Far East and the Orient over a period of many years through its own distributors.

In Japan the company is represented by the Mitsubishi Shoji Kaisha, Ltd., trading concern of the Mitsubishi organizations. The interest resulting in this relationship commenced in 1923, and in 1924 the company sent a representative to Japan to introduce its various products. In June 1926 a contract was made between Associated and Mitsubishi Shoji Kaisha, Ltd. for the exclusive representation and the trend of business there has been upward even through the depression years. However, marketing conditions indicated the need of a refinery in Japan, and the company entered into a contract with the Mitsubishi organizations on an equal basis for the construction of a plant at Kawasaki near Tokyo. A modern 4,000-bbl. refinery was erected and operations commenced in December, 1931, under the name of the Mitsubishi Oil Company, Ltd. This enterprise has prospered and firmly established the position of the Associated Company in the Orient.

Distribution of the Mitsubishi Oil Company products is in the hands of Mitsubishi Shoji Kaisha, Ltd. One traveling in Japan sees modern architecture, at the filling stations, the very latest in pump, greasing, and air equipment.

Associated originally operated in the Philippine Islands through a distributor, but in August, 1924, took over the distributorship and commenced operations under its own name. Since that time there has been a steady increase in its business. In September, 1935, a bulk installation for the storage of gasoline, kerosene, and Diesel oil was built at its plant at Pandacan, a short distance from Manila. The company maintains distribution throughout the Philippine Archipelago from northern Luzon to Jolo and Mindanao in the south. Branch offices are maintained in Debu, Iloilo and Legaspi.

In India, representation of the company and distribution of its many products is through Tide Water Oil Company (India) Ltd. at Calcutta. A flourishing trade in lubricating oils has been developed. Tide Water Oil Company (India) Ltd. has branch offices at Karachi, Bombay, Madras, Rangoon and Ceylon, which permits the adequate distribution of products throughout the Empire.

In China, the company is represented by the Jardine Engineering Corporation, Ltd., in Shanghai with branch offices at Hongkong, Tientsin, Canton, and Hangkow. Substantial progress has been made, especially with reference to lubricating oils as a result of a bulk installation for the storage and blending of these products at Shanghai. A thoroughly equipped plant was constructed on the Whangpoo River in 1934.

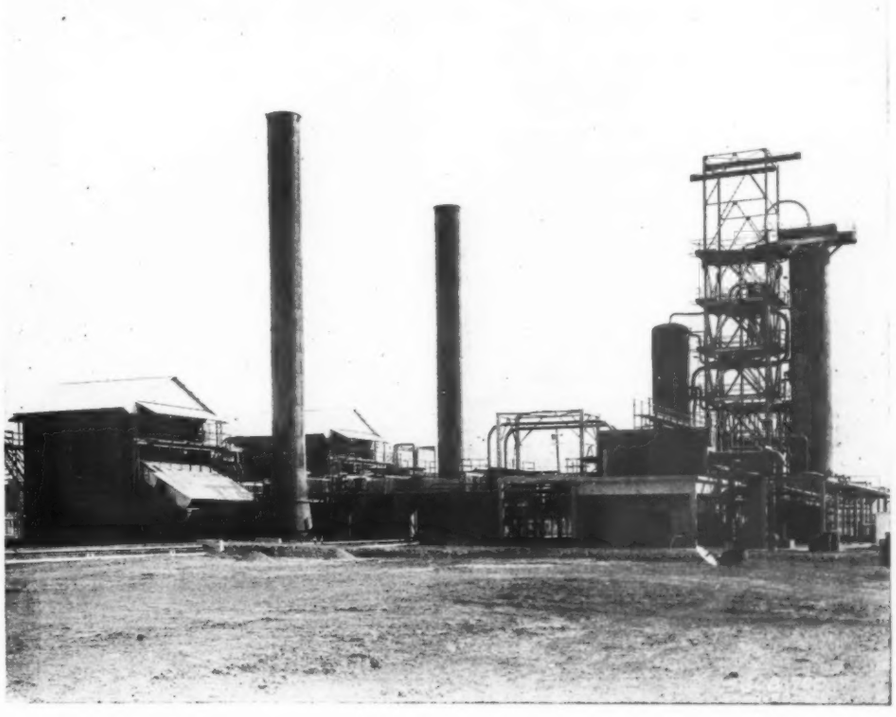
Following the consolidation in 1926, Tide Water and Associated continued to expand their operations under the control of Tide Water Associated Oil Company as a holding company. Particular attention was directed to strengthening production and reserves and to building up marketing business. Large additions to developed or semi-proven acreage have been made in Texas, New Mexico, Louisiana, California and other states.

In 1935 the company purchased the entire capital stock of Simms Oil Company with 450 wells in the Mid-Continent and Gulf Coast areas. In the latter part of 1936 it purchased the outstanding stock of Terrabella Investment Company with a participating interest in the Kettleman North Dome Association in California. By this move its share in this Kettleman development was increased to 4.26 percent.

On July 22, 1937, the Kettleman North Dome Association's discovery well 4-18-J was completed at a depth of 10,753 ft. or 2,000 ft. below the former producing horizons and is now reported with an initial production in excess of 1200 bbl. per day of 47 deg. gravity oil and with 2[illegible]00,000 cubic feet of gas. This discovery well is located less than one-half mile north of the Terra Bella holdings acquired by Tide Water Associated Oil Company. According to preliminary estimates of the company's engineers, this completion increases the Tide Water Associated Oil Company's crude oil reserves in California by approximately 15,000,000 bbl.

During 1936 Tide Water Associated acquired 172,743 shares, or 17 percent, of the capital stock of South Penn Oil Company, one of the most important companies in the Pennsylvania field producing high grade crude which is advantageous to Tide Water Associated in

Tide Water Associated's cracking unit at Avon, California, designed and erected by E. B. Badger & Sons Company.



the manufacture of its lubricants. Tide Water Associated and South Penn for many years have been equal owners of the Bradford Transit Company, a corporation which owns the most important pipeline gathering system serving the Bradford field.

THE COMPANY TODAY

The merger of Tide Water Oil Company and Associated Oil Company with and into Tide Water Associated Oil Company was consummated on November 30, 1936. Tide Water Associated was thereby transformed from a holding to an operating company actively directing all branches of the consolidated business. Out of a total of 35,624 stockholders in the three companies, owning an aggregate of 11,216,673 shares, only nine stockholders representing 28 shares of preferred stock and 4 shares of common stock of Tide Water Associated Oil Company, and 4,102 shares of the capital stock of Associated Oil Company voted against the merger. The merger was effected primarily to eliminate the disadvantages attending the company's previous capital structure and the increasing tax burdens imposed on it because of its "holding company" character. The percentage of the company's earnings theretofore received by the owners of preferred stock in proportion to that enjoyed by the owners of the common stock indicated that the company's unbalanced capital structure should be corrected. As early as 1934, the officers and directors of the company directed their attention to a plan, the completion of which would reduce the charges ahead of earnings available for the common stock (without trespassing on any of the rights or privileges of the owners of preferred stock), would avoid the increased tax burdens with which holding companies were seemingly threatened, and would eliminate, as far as practicable, other disadvantages of the company's capital structure. After careful study it was decided to attack the problems progressively: first, retire the 5 percent preferred stock of Tide Water Oil Company; second, liquidate into their respective parent companies certain subsidiaries of Tide Water Oil Company and of Associated Oil Company; third, merge the last named companies into Tide Water Associated Oil Company, and by the merger agreement amend the certificate of incorporation to permit reasonable flexibility for the necessary refinancing operations; and finally, refund the company's 6 percent cumulative preferred stock and its long term obligations.

Upon approval of the merger agreement by the stockholders, the directors formulated a program to refund the $62,622,100 of the 6 percent preferred stock and to refinance $18,800,000 of long term obligations through an issue of 500,000 shares of $4.50 cumulative convertible preferred stock without par value, and a 3½ percent fifteen year sinking fund debenture issue of $40,000,000. Negotiations were undertaken with Kuhn, Loeb & Co. and Lehman Brothers, representing themselves and 72 investment houses for the purchase of the proposed issues, subject, however, to the rights of the owners of the outstanding 6 percent preferred stock to exchange their holdings for an equivalent number of shares of the new $4.50 preferred stock without par value, and $2.00 per share in cash, and further subject to the right of holders of shares of the common stock of the company to purchase at $103 per share, plus accrued dividends, any unexchanged shares of the new preferred stock. Contracts with the underwriters required them to offer the debentures to the public at $101, plus accrued interest, netting the company $99, plus accrued interest, and the shares of the new $4.50 preferred stock at $103 per share, plus accrued dividends. The program met with gratifying acceptance by the stockholders and by the public alike, as the entire debenture issue was taken by the public before the end of the second day of the offering, and the stockholders acquired by exchange and purchase 436,668 shares of the new $4.50 preferred stock, leaving only 63,332 shares available to the underwriters.

It is estimated that $1,115,000 in interest and dividends annually will be saved initially as a result of the merger and financing program and that, on the basis of present laws, taxes will be reduced approximately $600,000 per year, making a total estimated annual saving of $1,715,000. Other savings through merged operations may not be estimated, but the total savings of all descriptions should be realized beginning with the year 1938.

As a result of the merger and refinancing programs, the capital and long term obligations of the company as of March 31, 1937, were as follows:

6,319,258	shares of common stock of $10 par value;
500,000	shares of $4.50 cumulative convertible preferred stock without par value, stated at a total of $50,000,000;
$40,000,000	fifteen-year 3½ percent sinking fund debentures to be retired at the rate of not less than $1,500,000 annually, payable in semi-annual installments on May 20th and November 20th of each year.

In starting off this new chapter in its history, Tide Water Associated Oil Company presents itself as a thoroughly integrated organization strongly buttressed in every department of its business. Its total assets amounted to $203,397,922 as at June 30, 1937. The financial progress of the company is indicated by the following table giving net income for the past four years.

During the first six months of 1937, earnings of the Company were reported at $7,696,701, or 99c per share, an increase of 45 percent over the first six months of 1936. This was the most successful January to July period in the company's history. During the six months' period, sales of petroleum products together with revenue from other operations, were $69,898,296., an increase of 24 percent over the first half of 1936.

TIDE WATER ASSOCIATED NET PROFITS

Year	Net Income
1933	$7,265,301
1934	5,810,657
1935	7,865,701
1936	10,217,927

Within the past few months newspaper releases erroneously reported that the shares of capital stock of Tide Water Associated Oil Company owned by Mission Corporation represented actual or working control of Tide Water Associated. Such reports were absolutely incorrect. The highest number of shares of the capital stock of Tide Water Associated Oil Company ever owned or controlled by Mission Corporation did not represent actual or working control of Tide Water Associated, and in March, 1937, the number of such shares so owned by Mission Corporation was greatly reduced. At that time, the exercise of an option to purchase from Mission Corporation 250,000 shares of the common stock of Tide Water Associated Oil Company reduced the holdings of Mission Corporation in Tide Water Associated to less than 13 percent.

The shares of capital stock of Tide Water Associated owned by the group of corporations called the "Getty interests" were not represented at the annual meeting on May 6, 1937. The same releases reported that the Getty interests had control of Mission Corporation. However, at the annual meeting in May, even if the shares of capital stock of Tide Water Associated owned by both Mission Corporation and the Getty interests were not counted or represented, there were represented and voted at the meeting for the election of directors 619,244 shares more than a majority of the total outstanding shares of the capital stock of Tide Water Associated Oil Company.

In the seventy years of their existence, Tide Water Associated and its former subsidiaries—Tide Water Oil Company and Associated Oil Company—have grown far beyond the fondest dreams of their founders. When Benson and Hopkins started their backwoods enterprise, or even when Porter and Bell gathered the Kern River producers into a cooperative enterprise they could scarcely envision a company whose products would one day be sold around the world. But it is fair to say that the remarkable growth of the company and its sound success is due to the fact that those who succeeded these pioneers have adhered to the principles they laid down. The spirit of the two young lumbermen who entered the oil business with their sawmill as financial inusrance still lives in Tide Water Associated Oil Company.

WORLD OIL PRODUCTION—Official Figures

All figures furnished direct to WORLD PETROLEUM by governments, except where otherwise specified—Table revised monthly

(Figures in U. S. Barrels—Conversion ratio 7 bbl. = 1 ton)

Country	July 1936	August 1936	September 1936	October 1936	November 1936	December 1936	January 1937	February 1937	March 1937	April 1937	May 1937	Provisional Figures June 1937
United States	92,087,000	95,090,000	90,972,000	95,795,000	91,018,000	97,652,000	98,567,000	93,173,000	106,724,000	104,979,000	110,911,800	105,380,000
Russia	16,231,600	15,737,500	14,936,600	16,118,900	16,019,700	16,412,900	15,476,300	13,247,300	15,800,000[1]	15,900,000[1]	16,000,000[1]	16,250,000
Venezuela	14,566,510	14,632,737	14,626,073	13,888,287	14,307,650	8,452,626	9,888,298	13,583,024	15,584,002	15,192,324	16,032,625	16,820,370
Roumania	5,606,000	5,585,000	5,254,000	5,224,000	4,982,000	5,050,000	4,760,000	4,217,000	4,595,030	4,412,000	4,494,000	4,151,000
Iran[2]	4,872,000	5,117,000	4,487,000	4,704,000	4,620,000	4,963,000	5,250,000	4,417,000	5,866,000	5,768,000	5,789,000	5,700,000
Netherland India	3,725,491	3,715,887	3,731,973	4,059,426	4,139,954	4,190,578	4,267,148	4,011,266	4,405,436	4,348,185	4,553,298	4,454,725
Mexico	3,179,614	3,773,503	3,768,855	3,235,224	3,204,007	4,259,733	4,233,635	3,922,929	4,307,952	4,249,838	3,387,953	3,338,000
Iraq[6]	2,440,669	2,479,428	1,881,782	2,097,564	2,214,954	2,207,954	2,476,698	2,240,119	2,542,883	2,501,772	2,578,401	2,200,254
Colombia[3]	1,585,345	1,553,606	1,575,273	1,600,288	1,537,683	1,641,636	1,668,490	1,617,441	1,622,226	1,660,469	1,678,580	1,724,173
Peru[4]	1,524,303	1,527,072	1,478,482	1,507,433	1,445,605	1,492,023	1,448,545	1,321,989	1,464,979	1,412,094	1,435,796	1,412,678
Argentina	1,286,536	1,293,283	1,323,730	1,306,784	1,356,396	1,356,396	1,355,029	1,237,459	1,317,000[1]	1,267,000[1]	1,270,000[1]	1,278,000
Trinidad	1,121,583	1,108,969	1,126,420	1,179,611	1,154,093	1,231,365	1,263,456	1,157,408	1,287,097	1,301,260	1,351,198	928,752
British India	817,364	815,415	791,217	730,860	778,617	809,218	757,936	756,857	803,327	688,000[1]	730,000[1]	750,000
Bahrein[7]	564,607	780,265	422,799	209,086	419,643	619,910	730,064	549,260	799,800[1]	650,000[1]	544,000[1]	582,000
Poland	294,000	301,000	294,000	301,000	294,000	301,000	295,400	273,000	292,600	294,000	310,000[1]	295,000
Brunei	266,700	275,310	257,040	294,070	294,560	322,210	354,480	327,600	357,630	333,410	343,310	320,810
Germany	272,699	257,859	255,556	277,158	265,650	279,545	265,531	233,366	245,007	249,088	247,100	248,000
Japan	206,284	221,139	207,260	200,528	202,385	212,326	219,410	194,037	207,423	198,898	206,544	203,000
Ecuador	163,714	160,914	158,857	168,892	163,870	175,918	180,058	160,675	180,727	181,352	189,658	182,711
Sarawak	130,200	129,150	122,010	127,330	122,980	128,240	125,440	114,380	125,650	119,770	123,480	120,820
Canada[5]	139,940	139,789	135,623	137,004	129,152	139,701	141,078	153,906	175,575	188,014	192,845	184,000
Egypt	106,260	102,620	98,812	102,109	97,755	98,672	99,589	86,842	93,499	89,544	97,146	98,091
France[1]	44,981	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000
Others[1]	60,000	56,000	50,500	47,000	42,000	38,000	37,000	40,000	39,000	43,000	45,000	44,000
Total	151,284,400	154,898,446	148,000,862	153,356,554	149,155,194	152,178,951	153,913,585	147,281,058	168,881,813	166,072,018	172,556,731	167,721,384

[1]Estimate. [2]Anglo-Iranian Oil Co. Ltd. figures revised; fuel oil returned to the ground has been deducted. [3]International Petroleum Company figures. [4]International Petroleum Company and Lobitos Oilfields Ltd. figures. [5]Includes natural gasoline production. [6]Exports. [7]Bahrein Petroleum Co. Ltd. figures.
Russian Sakhalin included with Russia. Japanese Sakhalin included with Japan.

Official Crude Oil Production Figures for 1932 to 1937

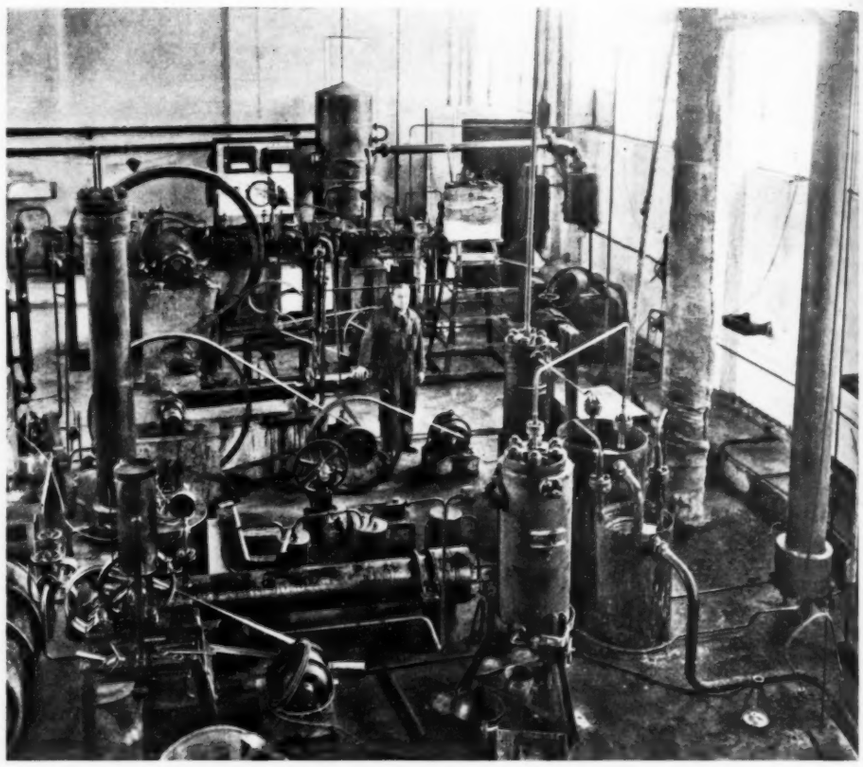
Country	Daily Average to June 30 1937	Daily Average 1936	Total to June 30 1937	Total 1936	Total 1935	Total 1934	Total 1933	Total 1932
United States*	3,429,474	3,001,410	620,734,800	1,098,516,000	996,596,000	908,065,000	905,656,000	785,159,000
Russia*	512,010	523,754	92,673,800	191,694,100	176,688,100	168,648,700	149,311,000	149,725,000
Venezuela*	481,219	438,844	87,100,643	160,617,095	153,932,614	140,784,804	121,052,354	119,597,337
Roumania*	147,166	173,587	26,637,000	63,532,846	61,270,072	61,849,306	53,919,708	53,651,978
Iran*	181,160	156,794	32,790,000	57,386,833	52,413,879	52,761,604	49,606,942	45,120,656
Netherland India*	143,922	131,043	26,050,058	47,961,744	45,307,913	45,107,828	41,234,498	37,988,913
Mexico*	129,504	112,098	23,440,304	41,027,915	40,240,563	38,171,946	34,000,830	32,805,496
Iraq*	80,331	76,711	14,540,127	28,076,167	25,733,839	7,214,216	1,018,290	818,300
Colombia	55,090	51,246	9,971,379	18,756,110	17,617,645	17,340,724	13,157,127	16,834,956
Peru*	46,939	48,068	8,496,081	17,593,069	17,056,555	16,314,381	13,257,318	9,899,265
Argentina	42,621	42,294	7,714,488	15,479,692	14,317,500	14,045,652	13,759,565	13,166,900
Trinidad*	40,272	36,167	7,289,171	13,237,030	11,671,224	10,894,363	9,561,353	10,126,121
British India*	24,785	25,980	4,486,120	9,508,903	9,218,925	9,200,072	8,743,115	8,817,315
Bahrein*	21,299	12,690	3,855,124	4,644,635	1,264,807	285,072	31,977	902
Poland*	9,723	10,576	1,760,000	3,871,000	3,902,000	4,012,000	4,174,000	4,220,000
Brunei	11,255	8,667	2,037,240	3,162,040	3,162,614	2,673,041	1,963,661	1,233,925
Germany*	8,221	8,503	1,488,092	3,112,200	2,991,800	2,222,500	1,670,200	1,607,900
Japan*	6,792	6,568	1,229,312	2,403,072	2,294,878	1,872,837	1,504,412	1,683,439
Ecuador	5,940	5,252	1,075,181	1,922,215	1,731,785	1,636,619	1,619,902	1,597,641
Sarawak	4,030	4,253	729,540	1,556,660	1,811,297	1,948,044	2,289,472	2,274,043
Canada*	5,720	4,110	1,035,418	1,504,287	1,447,204	1,410,895	1,145,333	1,044,412
Egypt*	3,119	3,395	564,711	1,242,437	1,235,052	1,502,697	1,627,137	1,855,392
France	1,492	1,562	270,000	534,063	529,664	700,000	786,366	755,146
Others	1,370	1,289	248,000	472,000	541,000	613,000	530,000	495,000
	5,393,454	4,884,861	976,216,589	1,787,812,113	1,642,976,948	1,509,275,301	1,431,620,580	1,300,479,037

*Revised by official sources. The above table is undergoing thorough revision, and statistics will continue to be checked, and corrected where necessary, in subsequent issues.

HYDROGENATION of Albanian Crude in Italy

By Rudolf Seiden

Catalytic Hydrogenation for Production of Gasoline and Lubricants from Albanian Crude Will Shortly Be Started in Italy—Accompanying Article, Together With Article on Albania in May World Petroleum, Is Intended to Indicate Political and Economic Importance of Chemical Possibilities Inherent in Even Limited Supplies of Albanian Crude.



Montecatini's Novara research laboratory—this hydrogenation plant is another stage of Italy's attempt at independence in liquid fuel supplies.

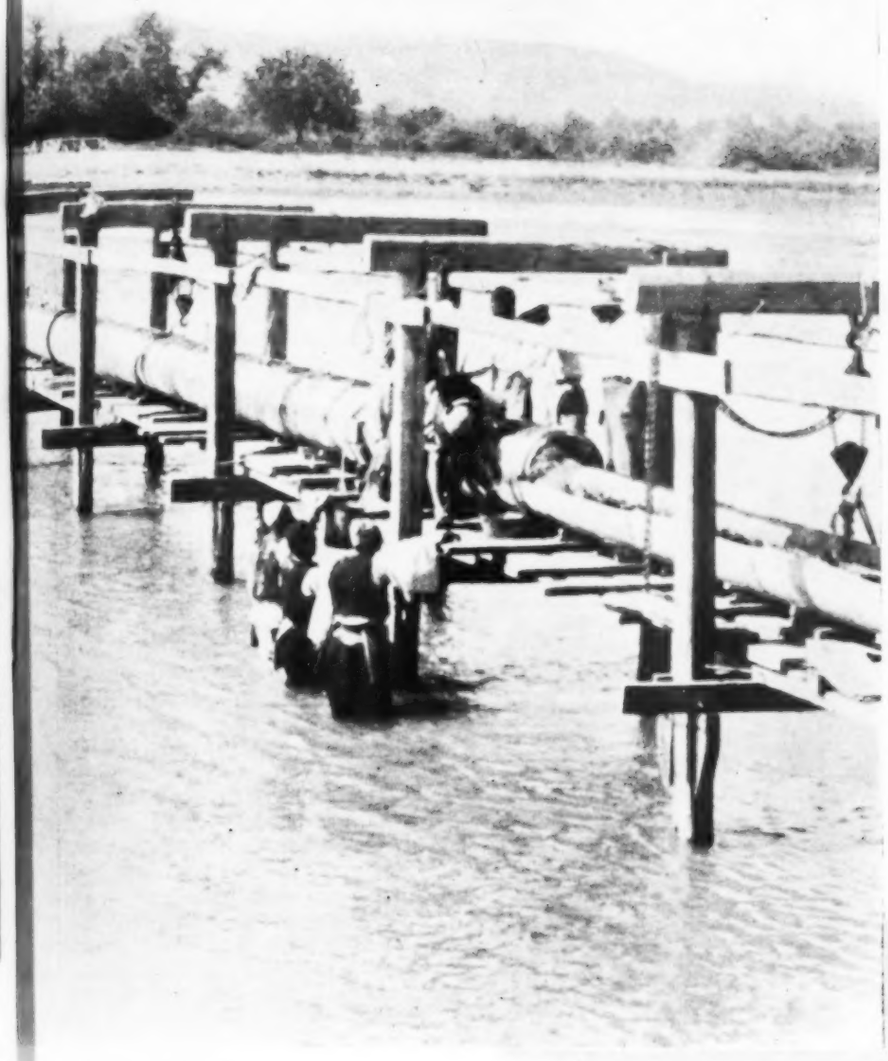
DUE TO the fact that Italy is poor in fuels the Facist Government has placed the problem of fuel synthesis at the head of its new political-economic autarchial program. At the present time the raw materials available to the Italians are limited to two: domestic brown coal (lignite) and the Albanian crude oil.

There is some uncertainty as to whether crude petroleum will ever be found in the Italian colonies in any considerable amount. Parenthetically it may here be noted that at the present time the Italians are doing some drilling on the Dalaac Island (opposite the port of Massaua), and at this writing have penetrated 200 meters with encouraging results so far as regards the indications given by the geological structure. It has therefore been decided to carry the well down as far as 1200 meters if necessary. Besides this the Italians possess a presumptive oil region in the neighborhood of Aussa (near the French Somaliland boundary); at this point the lately much-discussed Rickett Concession, which is now invalid, will be exploited.

The obscure political position in Europe, and certainly also the economic position of Italy, have induced Mussolini and his government to bring the Albanian crude oil within the scope of their autarchy program. Italy wishes to be prepared in case of war in the near future; it will not do to wait on the chance that supplies of fuel may be obtained from the Italian colonial possessions; for this reason it has been determined to depend upon resources already in hand and to build immediately two large scale plants in which the Albanian crude oil (which the Italians have at their disposal on the basis of a long time contract) will be transformed principally into gasoline and lubricating oils of high quality, using a recently developed process.

According to the most recent information regarding the main region of the Italian oil concession in Albania, with special reference to Devoli, a petroleum reserve of at least 84,000,000 bbl. can be counted on. This reserve is to be exploited over a period of 50 years, so that the Italians can count on at least 1,680,000 bbl. as an average yearly supply from this source. The new Devoli oilfields will begin to produce in the near future. The plan for exploiting this field was laid out by S. E. Benni. The daily production of this field is expected to be 7,000 bbl. of crude oil. A total of more than 100 wells have been drilled in this region; the production of these wells will be collected at two receiving tank farms and from there will be sent by three pump stations through the new pipeline to Valona, described in the May issue of WORLD PETROLEUM. It may be remarked on the side that this pipeline, which has a daily capacity up to 7,000 bbl., is constructed of seamless steel pipe 200 mm. in diameter and will sustain a pressure of 85 atmospheres. It is buried about one meter under the surface of the ground. The whole plant is elastically designed; the individual pumping stations can be cut out when the load is light or cut in when the load is heavy due to changes in the viscosity of the crude oil depending on the temperature of the region, which varies within wide limits. It may be noted finally that the collecting reservoirs in the

For permission to use the photographs that accompany this article, the author is indebted to Prof. A. Coppadoro, editor, "La Chimica e L'Industria" of Milan.

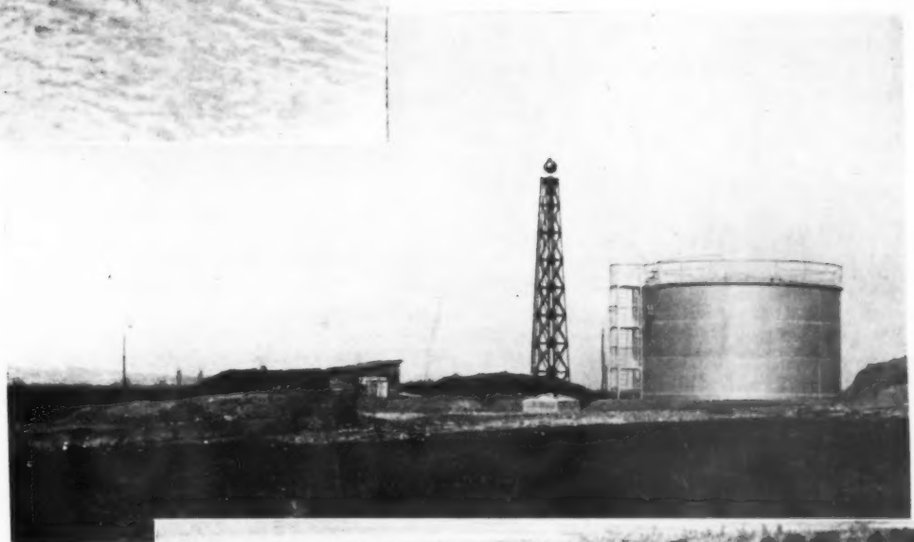


harbor of Valona have been put underground, and the crude oil is delivered to Italian tank steamers through pipe laid under water.

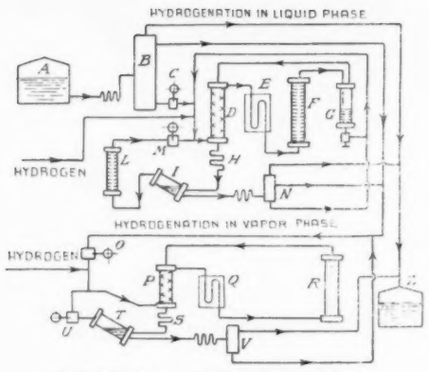
As previously noted the Italian crude oil production will cover only a small part of Italy's requirements for power fuel and lubricating oil. The main value of all Albanian oil lies in the fact that in the event of war Italy would have its own crude oil, because as a result of the 20-year alliance arranged on November 22, 1927, Albania has become to all intents and purposes an Italian dominion. For this reason, and because of the determination of the Italians to be economically independent, it will be easy to understand that the Italians wish to make the fullest possible use of the small quantity of Albanian oil reserves and to obtain from it the maximum of products which are all important for military airplanes, warships and other military purposes, lubricating oil as well as gasoline. At the present time Italy's consumption of lubricating oil is about 700,000 bbl. a year; in case of war requirements would be greatly increased due to the increasing motorization of the army and increased speeds of airplanes.

For these reasons the government and Italian chemists have been engaged for several years in developing a process by which they could obtain a maximum quantity of these important military supplies and which would be of some importance even in peace time, in view of the present heavy adverse trade balance due to importation of petroleum products.

By ordinary distillation and cracking, Albanian crude oil, which has a high sulphur content and an asphaltic base, yields at the most 40 percent of gasoline, the purification of which is expensive and difficult on account of the high sulphur content. The residue consists of heavy oil and muck coke, which are almost worthless. Therefore, as early as 1932 the Azienda Italiana Petroli Albania (AIPA) following a suggestion by Costanzo Ciano, began experiments on the hydrogenation of Devoli crude oil which is poor in the light fractions. The preliminary studies were made in the Fuel Division of the Istituto di Chimica Industriale del R. Politecnico in Milan under the direction of Professors M. G. Levi and C. Padovani. The work of Professor Levi has contributed greatly to the development of the new Italian hydrogenation process; on account of his



Upper left: construction of the Devoli-Valona pipeline across the Oshum River; center: crude oil storage tank at Devoli near the first pump station—note the searchlight; lower right: Group B of the Devoli field, Albania's principle oil producing area.



Graphical presentation of the hydrogenation process.

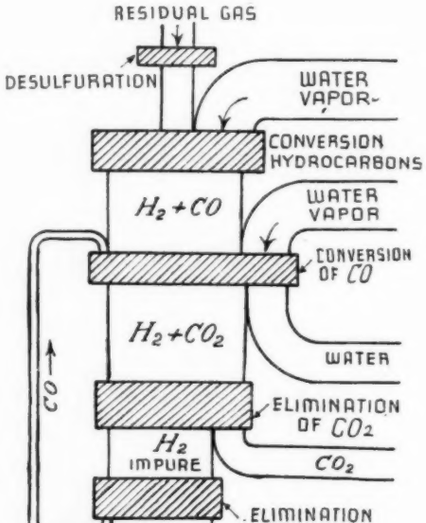
researches, which began as long ago as 1924, the Italian Technical Press calls him the Italian pioneer in this field of petroleum chemistry. His associates in hydrogenation research are Professor G. Roberti and Professor N. Parravano.

The practical testing of the various hydrogenation processes has been carried out chiefly in the research laboratory of the largest chemical concern in Italy: Montecatini in Novara, and the laboratories of the great German I. G. Farbenindustrie concern in Germany. The present intimate political relations between Italy and Germany have undoubtedly been strengthened by the intimate business and technical cooperation of these two influential industrial concerns.

Later on a semi-technical plant was erected in Novara, wherewith valuable practical experience was obtained in a few month's continuous operation. A chief point to be considered was the structural material question, the choice of contact masses, and construction details of the hydrogenation plants. It turned out that, by a choice of the best hydrogenation process, it is feasible to produce from the Albanian crude at least 80 percent of gasoline and this gasoline corresponds to the highest requirements as regards specific gravity and octane number. A very important point is that this same hydrogenation process can be used in the same plant for obtaining power fuels and lubricants from oil shales, rock asphalt, low temperature lignite tars, and other raw materials which are fairly abundant in Italy.

The results of these extensive researches and experiments have induced the Italian Government and Italian industry to collaborate in the erection of the first large scale hydrogenation plants in Italy. There is a new Italian law according to which enterprises of public interest cannot be made the subject of speculative maneuvers; as the first of these "enterprises of public interest" (Societa di utilita pubblica) the Azienda Nazionale Idrogenazione Combustibili (ANIC) has been founded with a capital of 400,000,000 lire. This capital has been taken half by the government and half by the Montecatini concern. The first two large plants are now under construction in Bari and Livorno; each of these plants will produce about 840,000 bbl. of gasoline a year along with lubricating oil, paraffin and liquefied gases as by-products.

There are two phases of the process to be distinguished, a liquid and a gaseous phase. From the container A in the accompanying diagram, the crude oil passes first to the stripping column B where the gasoline is separated from the middle oil and the residue. The residue is then forced by the high pressure pump C together with hydrogen into the heat exchanger D, from there into the preheater E and finally into the reaction tower F, where the hydrogenation takes place. The resultant hydrogenized products are now conducted into the hot separator G, where the heavy fractions settle out and the gasoline and light oils in vapor form, accompanied by the surplus hydrogen, return to the heat ex-



Purification of residual hydrogen.

changer D, where they give up their heat to the fresh charge. The cool vapor finally passes from the heat exchanger D to the condenser H and the cold separator I, where they are separated into gasoline and middle oil. The reaction products which still remain in the vapor phase pass through the wash tower L, where they are freed from hydrogen by means of an oil wash; the wash liquid is sent through pump M to the heat exchanger D, thus closing the cycle. On the other hand the liquid fractions from the cold separator I are distilled in the rectifying column N. The gasoline goes directly into the gasoline pump Z, while the middle oil passes into another division of the plant where it is subjected to a hydrogenation in the vapor phase.

The apparatus for the vapor phase is quite similar to that for the above described liquid phase, with the difference that the hot separator G is superfluous and is herefore omittted. It is consequently unnecessary to repeat the description of the individual pieces of apparatus fused for the vapor phase of the process; it will only be noted that a very pure gasoline is distilled from the reaction tower V and needs only to be given a wash with caustic soda; the fraction of middle oil which is not transformed into gasoline in this tower re-enters the cycle of the hydrogenation process.

Nothing has been given out regarding the contact masses used in this process. It is very clear that the catalyst is mixed with the oil product in the liquid phase, while for the vapor phase, contact surfaces having high resistance to poisoning are used; these contact surfaces are said to remain active for years.

In the construction of the plant it has been found possible to dispense with the use of special steel of high nickel and chromium content. Instead of these, use has been made of special alloys which, although they have smaller mechanical resistance, are very little subject to corrosion. The plants as a whole are constructed of common kinds of steel obtainable in the market and only certain special parts are lined with alloys.

The hydrogen gas required by the process is obtained from gaseous by-products that are formed in the process itself. These gaseous products consist chiefly of methane, which is first purified from hydrogen sulphide and then conducted along with a certain amount of water vapor into a cracking furnace where the mixture is catalytically converted at 800 deg. C. into carbon monoxide and hydrogen according to the well known formula:

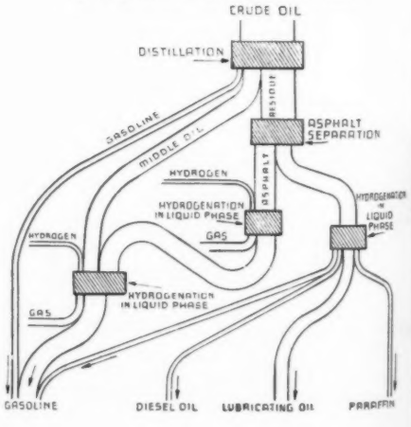
$$CH_4+H_2O=CO+3H_2$$

An additional quantity of water vapor is now mixed with this gaseous mixture, and in the presence of another catalyzer at 500 deg. C. the carbon monoxide is oxidized to carbon dioxide with production of an additional quantity of hydrogen originating from the water vapor according to the formula:

$$CO+H_2O=CO_2+H_2$$

Then the superfluous water vapor is removed by condensation, the remaining gaseous mixture is put under a pressure of 28 atmospheres and freed from carbon

Flow chart of complete distillation and hydrogenation of Albanian crude.



dioxide by a water wash. Traces of carbon dioxide, which may still remain to contaminate the hydrogen, are removed by compressing the gas in several stages to 300 atmospheres and washing it with an ammonia copper solution.

It is interesting to note how the difficult problems of supervision of the whole hydrogenation plant have been solved. The very complicated chemical transformation which goes on in the plant requires a continuous and very exact control if heavy damages and losses are to be avoided. A large number of recording and controlling instruments are therefore needed to show every alteration of temperature, pressure and quantity of material in each of the different stages of the cycle. All these indicating instruments are mounted in a single control room where the director of the plant or his assistant has a complete control of the whole process and can order the opening or closing of every individual valve in the whole plant.

Lubricants are obtained from the residue which remain after the primary distillation of the Albanian crude oil at temperatures above 320 deg. C. These residues are first vacuum-distilled to remove the asphaltic portion. This operation yields an oil of very low viscosity index—under 30—the yield corresponding to about 27 percent of the crude oil. On account of its low viscosity this product naturally can not be used for lubricating purposes but it is possible to raise the viscosity index to 70, 85 and even higher when the whole fraction is contacted at a certain temperature and a certain pressure for a certain time with the catalyst used in the liquid phase of the hydrogenation plant. This hydrogenation produces a high quality lubricating oil which answers all requirements. At the same time there is obtained a high quality light oil with a high cetene number suitable for Diesel motors, and also a certain quantity of paraffin.

It is expected that the new Italian hydrogenation plants will work not only on Albania crude oil but also, among other raw materials, on coal tar. The employment of coal tar is much more economical than solid coal as a raw material because the hydrogen consumption is considerably smaller. However, the operation of the plants is more satisfactory as regards yields and technological convenience when crude petroleum is used as the raw material.

Here is a case where research and technology have again collaborated successfully in solving a difficult proposition. It is no small accomplishment to have converted the very low quality Albanian crude oil into high quality distilled products in good yields. It is therefore to be expected that the Italians will in the coming year endeavor to strengthen their interests in Albania and to make this small Balkan state still more economically and politically dependent on Italy than it has been in the past ten years. It will be interesting to see how the other non-Italian petroleum concessionaires in Albania will come off, whether their efforts will be promoted or rendered difficult by the government.

RECRUIT FOR RIPLEY

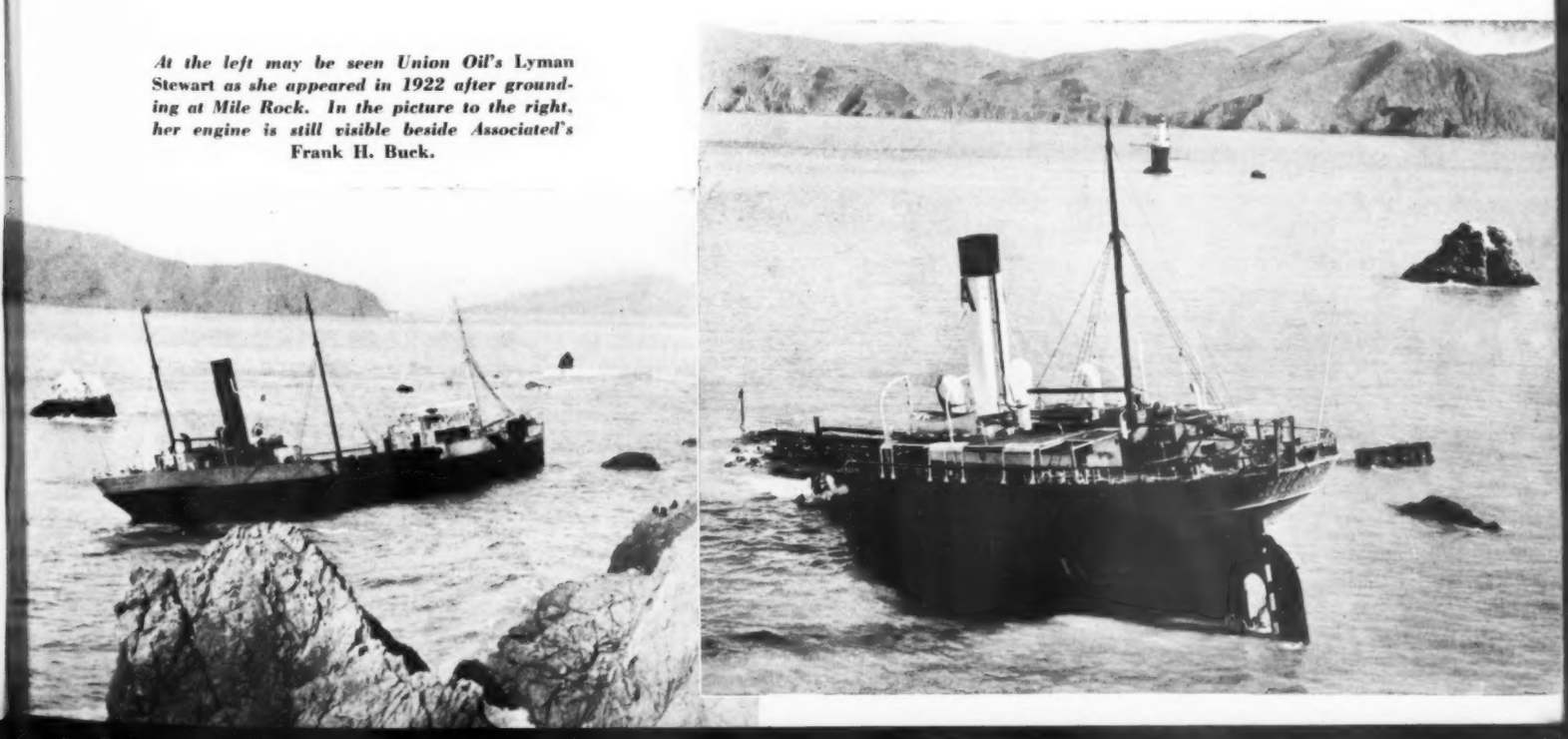
BUILT in the same year to the same specifications, two Pacific Coast tankers went their diverse ways, one for eight years, the other for twenty-three, each to meet an exactly similar fate, fifteen years apart, in almost the identical spot, and both to end together close by their birthplace.

Worthy of a place in Robert Ripley's famous "Believe it or Not" is the story of these two vessels, the LYMAN STEWART and FRANK H. BUCK, both built by the Bethlehem Shipyards at San Francisco in 1914. Without mishap, at least of major consequence, they engaged in petroleum transportation until October 7th, 1922, when the LYMAN STEWART collided with another vessel off Point Lobos, and finally piled up on the rocks below the Cliffhouse, at Mile Rock, a total loss. Thus the first of the sisters returned to perish at the Golden Gate, from whence she had so proudly set out just eight years before.

The FRANK H. BUCK continued serenely on her way, mostly to and from Pacific Coast ports, but occasionally venturing on more extended trips to Honolulu, South America and the East, with little interruption until she also collided with another ship—at almost the identical spot where her sister-ship met disaster in 1922— on March 3rd, 1937. Efforts were made to tow her to port, but she grounded, broke amidships, and settled down within fifty feet of the LYMAN STEWART.

The sea has been the source of many strange tales but none stranger than the peculiar series of coincidental experiences that befell the FRANK H. BUCK and the LYMAN STEWART.

***At the left may be seen Union Oil's* Lyman Stewart *as she appeared in 1922 after grounding at Mile Rock. In the picture to the right, her engine is still visible beside Associated's* Frank H. Buck.**



PROFIT FROM EAST TEXAS Impossible

With Daily Allowable Below 10 Bbl. Per Well

By Gilbert W. Noble

Due to Prolonged Life of Field Resulting from Proration, Interest Charges Must Be Calculated Over Extended Period Setting Economic Minimum for Per Well Allowable. Accompanying Article Indicates Method for Calculating This Minimum for Any Field on Which Reliable Cost Figures Are Available.

TABLE I

Analysis of Cost of Producing East Texas Oil

100 Wells Spaced 6.5 Acres per Well: Production Rate 21 bbl. per Well per Day: Company Net Interest 671,147 bbl. per year: Interest Rate 6%

	Natural Flow	Gas Lift	Pumping
1. Expenditures incurred before any substantial portion of the oil is produced.			
Leasing and exploration cost	$ 180,000.00	$ 180,000.00	$ 180,000.00
Cost of operated acreage	580,000.00	580,000.00	580,000.00
Cost of drilling and equipping wells for flow	1,500,000.00	1,500,000.00	1,500,000.00
Extra cost for auxiliary lifting	....	90,000.00	200,000.00
Total capital sum to be repaid out of profits	$2,260,000.00	$2,350,000.00	$2,460,000.00
2. Fixed charges that are incurred so long as wells produce, but that are not affected by changes in rate of production:			
Fixed lifting costs per day (see also below)	$115.25	$115.25	$115.25
Overhead per day	140.00	140.00	140.00
Total fixed charges per day	$255.25	$255.25	$255.25
3. Costs that depend primarily on the quantity of oil produced:			
Taxes per barrel	$.0525	$.0525	$.0525
Lifting cost—chiefly fuel and power and charges of service units per barrel[1]	....	.0325	.1575
Total costs per barrel based on production rate	$.0525	$.0850	$.2100

[1] Cost per bbl. net company oil. Since the company must also lift the royalty oil the actual cost per bbl. for all oil lifted is ⅛ less than listed here.

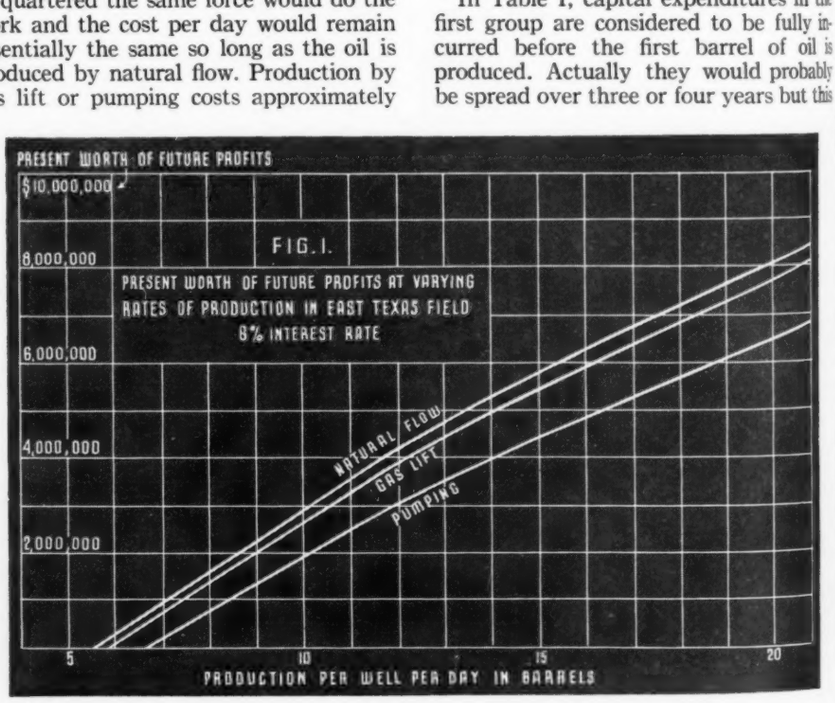
WHEN wells were permitted to flow wide open in the East Texas field the original investment was often repaid in a few weeks and the bulk of the oil might have been produced in four or five years. At current production costs and value of crude the development cost would have been repaid almost as soon as incurred and profits deferred only four or five years are worth almost face value. Pro-ration has been beneficial in conservation of reservoir energy and in warding off demoralization of price structure by preventing serious over-production; on the other hand, it has necessarily greatly prolonged the producing life of oil fields which in turn has resulted in tying up initial investment for longer periods of time and by deferring production of much of the oil for many years has materially reduced the present worth of profits to be realized from production in the future.

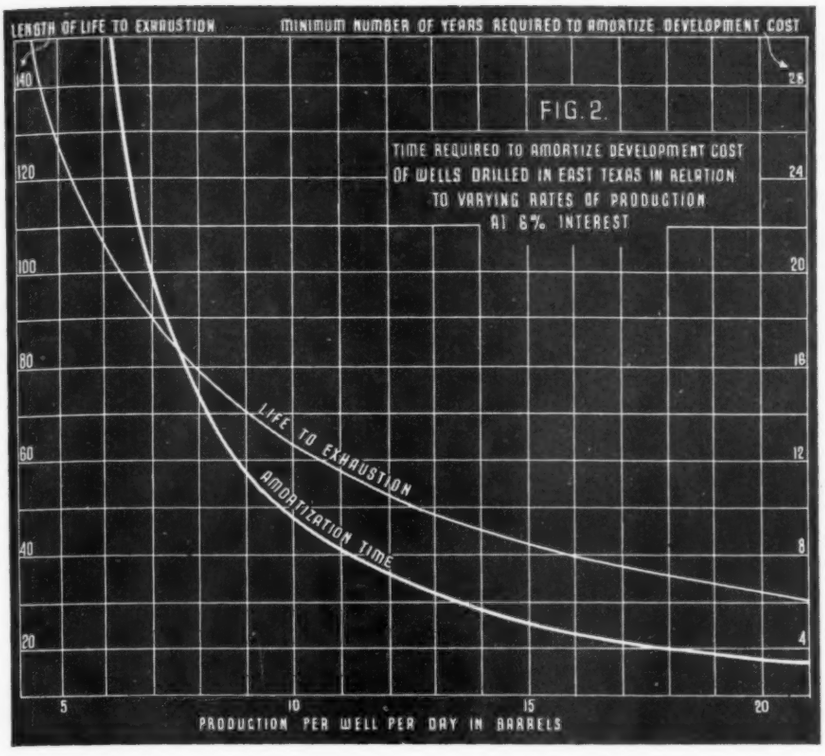
The analysis of costs given in Table I is considered applicable to an average tract of 650 acres with the present spacing of about 6.5 acres to the well and present production of about 21 bbl. per well per day in the East Texas field. Leasing and exploration cost and cost of operated acreage will remain the same whether or not more wells are drilled on the tract. The cost of drilling and equipping wells for flowing is based on a figure of $15,000.00 per well. The costs of auxiliary lifting equipment are based on estimates of $900.00 per well for gas lift and $2,000.00 per well for pumping. The cost of drilling wells has been materially decreased so if additional wells are subsequently drilled on the tract a charge of $11,500.00 per well should be added, but the same cost per well for auxiliary lifting equipment should be used.

To keep the hundred wells on the tract producing costs about $115.25 per day under present conditions; if the rate of production per well were doubled or halved or quartered the same force would do the work and the cost per day would remain essentially the same so long as the oil is produced by natural flow. Production by gas lift or pumping costs approximately the same amount per day plus an additional charge per barrel to cover extra fuel and power and higher cost of servicing auxiliary lifting equipment. Overhead for operating the tract costs about $140.00 per day and will not be materially changed by varying the production per well per day whether the oil is produced by natural flow, by gas lift, or by pumping. Taxes—chiefly gross production or severance tax—amount to about $0.0525 per barrel.

EFFECT OF TIME ON VALUE OF PROFITS

In Table I, capital expenditures in the first group are considered to be fully incurred before the first barrel of oil is produced. Actually they would probably be spread over three or four years but this





is not very important when compared with the 30 year life of the tract under the present producing rate of 21 bbl. per well per day. Since this development must be finished before the oil is produced, some method of financing is necessary. The larger companies can finance their own development, whereas the smaller independent operators often have to rely on outside financing. In either case, development cost should be charged interest at whatever rate seems proper until such time as it is recovered out of profits.

The items in Group 2 of Table I—fixed charges on lifting cost and overhead—are paid currently out of gross operating income. They are chargeable at face value at the present time, but the present cost of these fixed charges in any future year is found by discounting the face value to present worth at the same rate at which interest is charged on the development cost.

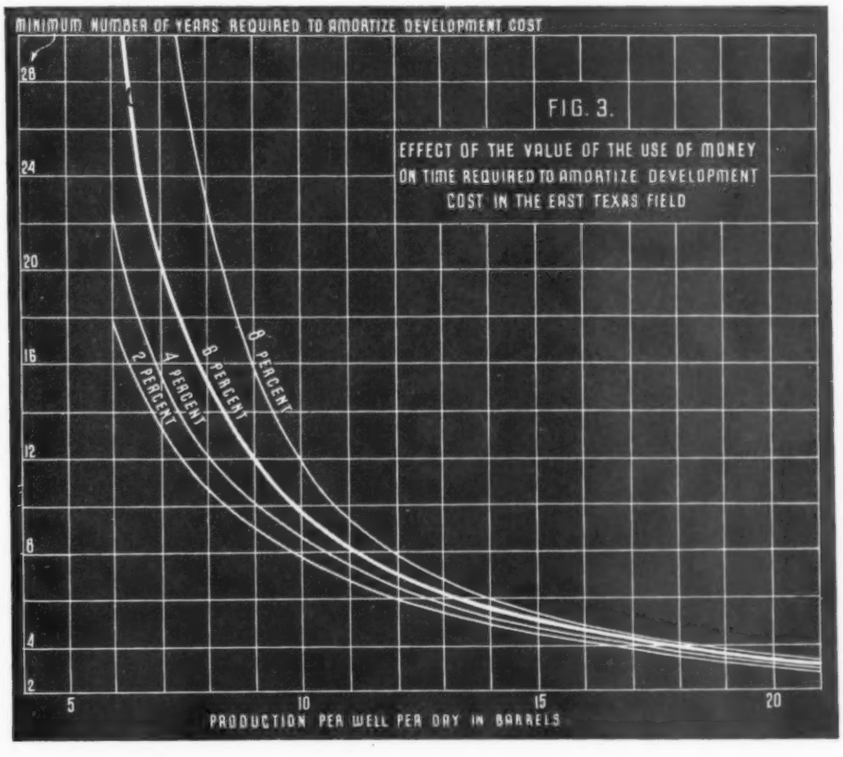
Items in Group 3 of Table I—taxes, extra fuel and power, and charges of servicing auxiliary lifting equipment—are based directly on the number of barrels lifted. They are paid currently out of gross operating income, but do not need to be discounted if they are handled as deductions from future profits which are subsequently discounted to present worth.

Development cost is incurred before production of oil begins; fixed charges not directly affected by rate of production must be paid year after year as long as the tract produces; and costs based primarily on the quantity of oil produced must be paid for every barrel produced year after year. All of these costs, plus the cost of financing the development, are paid for by sale of the oil as it is produced. At present, the time interval from initial development to ultimate exhaustion of the tract is 30 years (according to current estimates of reserves in the field); with the same oil reserves and the same number of wells, but with production per well per day reduced from 21 to 7 bbl. the time interval would be 90 years. Obviously, all costs and profits must be referred to some common point of reference in time if they are to have any meaning. The simplest and most useful point of reference would seem to be the present time, because the value of profits at different rates of flow can be more readily compared at their common point of origin rather than at their terminations at different times in the future.

The cost figures used in this analysis are considered applicable throughout the life of the tract and the current price of East Texas crude is likewise used throughout the period. If costs and price of crude maintain the same relative positions there will be no change in the present worth of future profits. If the same relation is not maintained different values will be obtained. No attempt is made here to show whether or not the present relation of costs to price of crude is stable, but if all factors except price of crude remain at current levels the present worth of future profits will vary from $13,062,413.83 for $1.85 crude down to a net loss of $55,860.00 for $0.43 crude, as shown in Table IV.

PRESENT WORTH OF FUTURE PROFITS

Table II presents a step by step computation of the present worth of future profits on the tract under discussion at the current production rate of 21 bbl. per well per day, considering that the use of money is worth 6 percent interest and that the development is repaid out of profits as fast as they are earned. So long as the same interest rate is used, the present value of all future profits is the same whether development is paid for as fast as possible or whether the development cost is prorated



Reading from left to right, Col. Ernest O. Thompson, Judge C. V. Terrell, chairman, and Senator Lon A. Smith of the Texas Railroad Commission which controls output from each field in the state.

TABLE II

Present Worth of Future Profits

100 Wells Spaced 6.5 Acres per Well: Production Rate 21 bbl. per Well per Day: Company Net Interest 671,147 bbl. per Year: All Production by Natural Flow: Interest Rate 6%.

Year	Taxes etc. at 5 ¼c	Fixed Charges	Interest on Balance of Investment	Total Expenses	Value of Oil at 1.35/bbl.	Out-of-Pocket Profit	Unpaid Balance of Investment at Beginning of Year	Profit or Deficit	Profit Discounted to Present Worth
1	35,235.22	93,230.06	135,600.00	264,065.28	906,048.45	641,983.17	2,260,000.00	—1,618,016.83 D	....
2	35,235.22	93,230.06	97,081.01	225,546.29	906,048.45	670,502.16	1,618,016.83	— 937,514.67 D	....
3	35,235.22	93,230.06	56,250.88	184,716.16	906,048.45	721,332.29	937,514.67	— 216,182.38 D	....
4	35,235.22	93,230.06	12,970.94	141,436.22	906,048.45	764,612.23	216,182.38	548,429.85	434,407.81
5	35,235.22	93,230.06	....	128,465.28	906,048.45	777,583.17	....	777,583.17	581,055.38
6	35,235.22	93,230.06	....	128,465.28	906,048.45	777,583.17	....	777,583.17	548,165.45

(D) Deficit

to total recoverable reserves and repaid on a per barrel basis as the oil is produced, though the computation is simpler in the former case. It can be seen that the development cost, plus cost of financing, could be paid back in about three and one-third years. While the accompanying Table II shows the computation for the first six years only, due to space limitations, an extension of this computation for thirty years would show that total profits obtained, when discounted to present worth, amount to $8,443,301.04 as indicated in Table III.

TABLE III

Summary of Computations of Profit Discounted to Present Worth if Extended Through 30 Years

Sum of years 1 to 6	$1,563,628.64
Sum of years 7 to 30	6,879,672.40
Sum of years 1 to 30	$8,443,301.04

This method of computation is tedious and if we are interested only in the present value of all future profits the computations can be enormously simplified by proper grouping of the items.

This simplified computation is given in Table V. It is made possible by considering each group of factors in Table I separately as if it were the only one operating and combining the subtotals of the separate steps to get the final resultant. Starting with 23,010,750 bbl. gross ultimate oil on the tract and deducting the ⅛ royalty interest we find the company's net working interest is 20,134,410 bbl., which at $1.35 per barrel is worth $27,181,453.50. Deducting taxes, etc. (Group 3 of Table I) at $0.05¼ per barrel leaves $26,124,396.98 as the sum of all profits not considering overhead and development cost. Since the production rate remains constant over the 30 year period this may be considered as the sum of the amounts received from a fixed annuity for 30 years. It can then be discounted to present worth by multiplying it by 1/30 of the present value at 6 percent interest of an annuity of $1 per year

TABLE IV

Present Worth of Future Profits at Various Prices for Crude

(21 bbl./day—6% interest—Production costs as Given in Table I)

Crude Oil Price	Profits Discounted to Present Worth
$1.85	$13,062,413.83
1.35	8,443,301.04
1.00	5,209,922.38
0.75	2,900,366.07
0.50	590,809.76
0.43	55,866.00 D

(D) Deficit

TABLE V

Present Worth of Future Profits

(6 Percent Interest Rate)

	Natural Flow	Gas Lift	Pumping
Bbl. per well per day	21	21	21
Years life to exhaustion	30	30	30
Gross ultimate production—bbl.	23,010,750	23,010,750	23,010,750
Net ultimate production (after deducting ⅛ royalty)	20,134,410	20,134,410	20,134,410
Value @ $1.35 per bbl.	$27,181,453.50	$27,181,453.50	$27,181,453.50
Taxes, etc. (Group 3 in Table I) @ 5 ¼c	1,057,056.52	@ 8½c 1,711,424.85	@ 21c 4,228,226.10
	$26,124,396.98	$25,470,028.65	$22,953,227.40
Discounted to present worth (.45882771)[1]	$11,986,597.24	$11,686,354.92	$10,531,576.77
Fixed charges (Group 2 in Table I) discounted to present worth (13.76483115)[2]	1,283,296.03	1,283,296.03	1,283,296.03
	$10,703,301.21	$10,403,058.89	$ 9,248,280.74
Development cost (Group I of Table I)	2,260,000.00	2,350,000.00	2,460,000.00
Present worth of future profits	$ 8,443,301.21	$ 8,053,058.89	$ 6,788,280.74

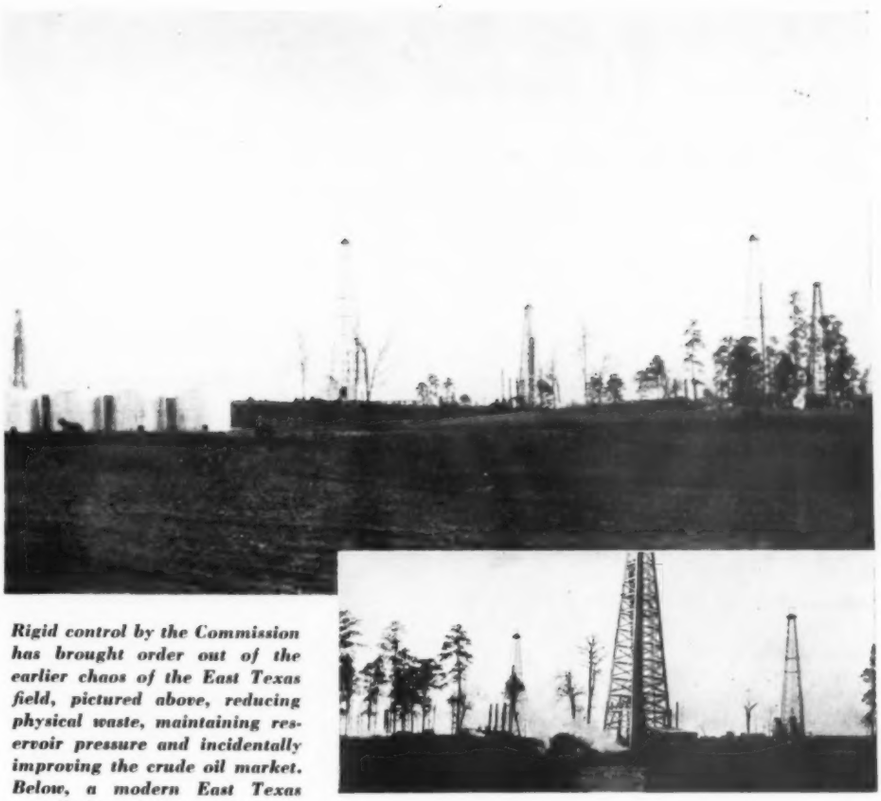
[1] Discount factor at 6% interest: represents 1/30 of present worth of $1.00 per year for 30 years.

[2] Discount factor at 6% interest: represents present worth of $1.00 per year for 30 years. When multiplied by the amount of fixed charges per year ($93,230.06) gives the discounted value of all fixed charges for 30 years.

for 30 years. The fixed charges of $93,-230.06 per year (Group 2 of Table I) can be considered an annuity owed someone else of $93,230.06 per year for 30 years and can be discounted to present worth by multiplying by the present worth at 6 percent interest of an annuity of $1 per year for 30 years. Deducting this from the discounted value of profits in the previous step we obtain $10,703,301.21 as the present worth of profits before paying the development cost. Development cost (Group I of Table I) is deducted at face value and no interest need be added as the cost of financing is compensated by discounting future profits to the present time which is the time the development cost is incurred. Comparison of final values of Tables III and V shows that the present worth of all future profits is the same by the two methods of computation—the slight difference being due to using discounting factors of only eight significant figures but carrying extensions actually to ten places.

The effects on the life of the property and the present worth of future profits brought about by reducing the rate of production per well per day are shown in Table VI and in Figure 1. From a purely theoretical point of view it would seem that under the conditions considered the lower limit of production to just break even would be 5.5 bbl. per well per day if all oil could be flowed, 5.8 bbl. per well per day by gas lift, or 6.6 bbl. per well per day if all of the oil were pumped. It should be noted, however, that this means an ultimate life of 90 to 120 years and that at these limits it would take all the profits for from 24 to about 50 years to pay for the initial development, as may be seen in Figure 2. Practically, a pay-out on initial development of about 10 years would probably set the limit of producing rate that would allow the operator any profit because it would be extremely difficult to get outside financing for a venture of this type, for a longer period of time than this. Accordingly a production of 10 bbl. per well per day seems to be necessary to allow any profit to the average producer in East Texas if the use of money is considered worth 6 percent. Of course, if capital is obtainable at less than 6 percent corresponding adjustments in the foregoing calculations would be necessary.

In Figure 3 it may be seen that if the use of money is worth only 2 percent production of 8.3 bbl. per well per day will amortize the development cost in 10 years, whereas if the use of money is worth 8 percent production of 10.7 bbl. per well per day is required to return the development cost with interest in 10 years. It is intended here to illustrate a method in which proper adjustments for varying interest rates, development costs, price and allowable could be made to adapt the method to any prorated field.



Rigid control by the Commission has brought order out of the earlier chaos of the East Texas field, pictured above, reducing physical waste, maintaining reservoir pressure and incidentally improving the crude oil market. Below, a modern East Texas well along the river bottom.

VI

Present Worth of Future Profits as Production Rate Is Decreased

(6 Percent Interest Rate)

Rate of Production Bbl./well/day	Life to Exhaustion (years)	Minimum Time Required to Amortize Development Cost (years)	Present Worth of Future Profits		
			Natural Flow	Gas Lift	Pumping
21	30	3.3	$8,443,301.21	$8,053,058.89	$6,788,280.74
18	35	4.0	7,209,980.99	6,848,918.38	5,696,369.88
15	42	5.1	5,790,422.96	5,463,221.60	4,440,908.69
12	53	7.0	4,172,420.86	3,884,153.85	3,011,588.43
10	63	9.5	2,961,021.73	2,702,314.62	1,943,441.10
7	90	20.0	966,682.81	796,143.11	222,528.85
6	105	35.2	327,184.06	133,544.85	—375,067.51 D
5	127	Infinity	—359,389.25 D	—535,892.99 D	—978,599.68 D

(D) Deficit

IMPORTANT NEW FIELD
Expected in Illinois Basin

By A. G. Hillen

JULY 17TH, 1937.

ON MAY 23RD last, when the Bunyan Travis No. 1 well of the Pure Oil Co., at Clay City, Clay County was drilled in at 3,000 ft. with flush production of 2,644 bbl. of 40.8 gravity oil in 24 hours and a gas volume of 1,220,000 cu. ft., this area was put on the oil maps of most of the big producing companies. Not far behind the "Bunny" may be cited completion of three new wells in the Patoka field from the McCloskey sand May 25th to June 1st at 1,467 to 1,487 ft. depth, located 42 miles west of Clay City, and 14 miles north of Sandoval in Marion county and completion of several others in Clinton county at Bartelso, eight miles southwest of Carlyle and some 24 miles from Patoka—all affording potentially proven or semi-proven productive oil sand areas in a constantly growing field.

A dozen wells have been completed in each of these fields and production has reached something more than 5,000 bbl. per day, priced around $1.25 per bbl. and there are prospects of doubling or trebeling this volume in the near future. Should success follow present drilling of numerous locations in any of the strictly wildcat areas spreading out from these productive fields from ten to as much as fifty miles distant, something in the nature of a real boom may be looked for.

In the area defined herewith an estimate of 1,000,000 acres under lease is quite conservative and a million dollars disbursed, is probably well within the facts. The basin area proper may be defined as from Duquoin to Decatur on a north-south line and from Olney to Carlyle and Bartelso east and west, roughly an oblong area about 75 miles wide and 100 miles in length, in which most of the big operating oil companies are active or represented in lease holdings, which leaseholds may stand either in the name of the companies or their representatives.

From day to day changes are taking place, new locations for wells are being made; new companies, individuals and contractors appear and announcements concering new leases and locations made, by the companies named on the accompanying list and others, perhaps not so well known. For instance, the Kingwood company, prominent as oil operators in Texas and Oklahoma, who are reported to have drilled 176 wells in those fields, will soon drill two test wells on 70,000 acres held by them in Effingham County, and others may be expected.

Indicating their confidence in the future oil production of the Illinois basin, two oil well supply firms have constructed local warehouses and stocked up with a dozen or more carloads of casing and oil well supplies, now on hand for local delivery, a convenience some of the older oil regions are still awaiting. There are a dozen or more of the largest and most expensive type of rotary drilling machines and numerous smaller outfits on the ground and others are coming or are in demand. Diesel power equipment plants have been installed or are proposed, one having capacity for pumping a string of twenty wells and supplying motive power for drilling. More or less permanent headquarters are being set up by several of the operating companies, at Clay City, Cisne, Patoka, Bartelso, Carlyle, Mattoon and Ohrey.

The grade of oil, running around 36 gravity in the various fields, is said to yield the maximum amount of light fractions with considerable lube oil stock as a by-product and trainload shipments are going out every few days to the refineries. Already there is talk of local refinery plant at some central point.

Many of the companies brought their crews and staffs from other fields and this includes the drilling contractors, who undertake to put down a well 3,000 ft. in 30 or 40 days, in many cases. Contractors are here from half a dozen states, most of them drilling for companies they ran holes for in their home fields.

As a matter of course, this oil activity centers at Flora, Clay City, Fairfield, Salem, Centralia, Olney, Effingham, Carlyle, Sandoval, and elsewhere as far north as Mattoon and south to Duquoin.

According to the check-up, test wells with equipment for drilling down to 7,000, 8,000 or 9,000 ft., should oil not be found above these levels, are being run by the Ohio Oil & Gas Co., at Noble; by Benedum & Trees at Xenia; by Dee & Carter at Ina, below Mt. Vernon, where it is anticipated that the Wilcox or St. Peters sand may be reached which is also looked for at the Duquoin deep test. Wildcatting outside the semi-proven oil districts is going forward and should any one of such efforts be successful, an important new field will result.

GEOLOGY OF ILLINOIS BASIN

A SUMMARY of the formations, proven by close study, by seismographic demonstrations and by geologic data published by the State Geological Survey of Illinois, supervised by M. M. Leighton, chief of staff, outlines an area 125 miles from north to south and 75 to 80 miles east to west, covering the No. 1 or probable oil region of Southern Illinois.

Portions of this area around Lawrenceville, Salem and Bartelso have been producing for several years from a shallow sand at depths from 700 and 800 ft. down to 1,300, and several of these wells are still productive after a lapse of 10 to 15 years, as at Salem and Sandoval.

Recently the department has compiled a series of contour maps, based upon drill records and the Albany shale, a thick black or brown shale, lying below the Mississippian limestones, often placed in the Devonian period and above the limestones and dolomites of the Devonian and Silurian systems.

The most important features of the Illinois basin are the LaSalle anticline, which in the north is said to divide the basin into two unequal parts, and the Rough Creek or Shawneetown fault zone that cuts across it to the south.

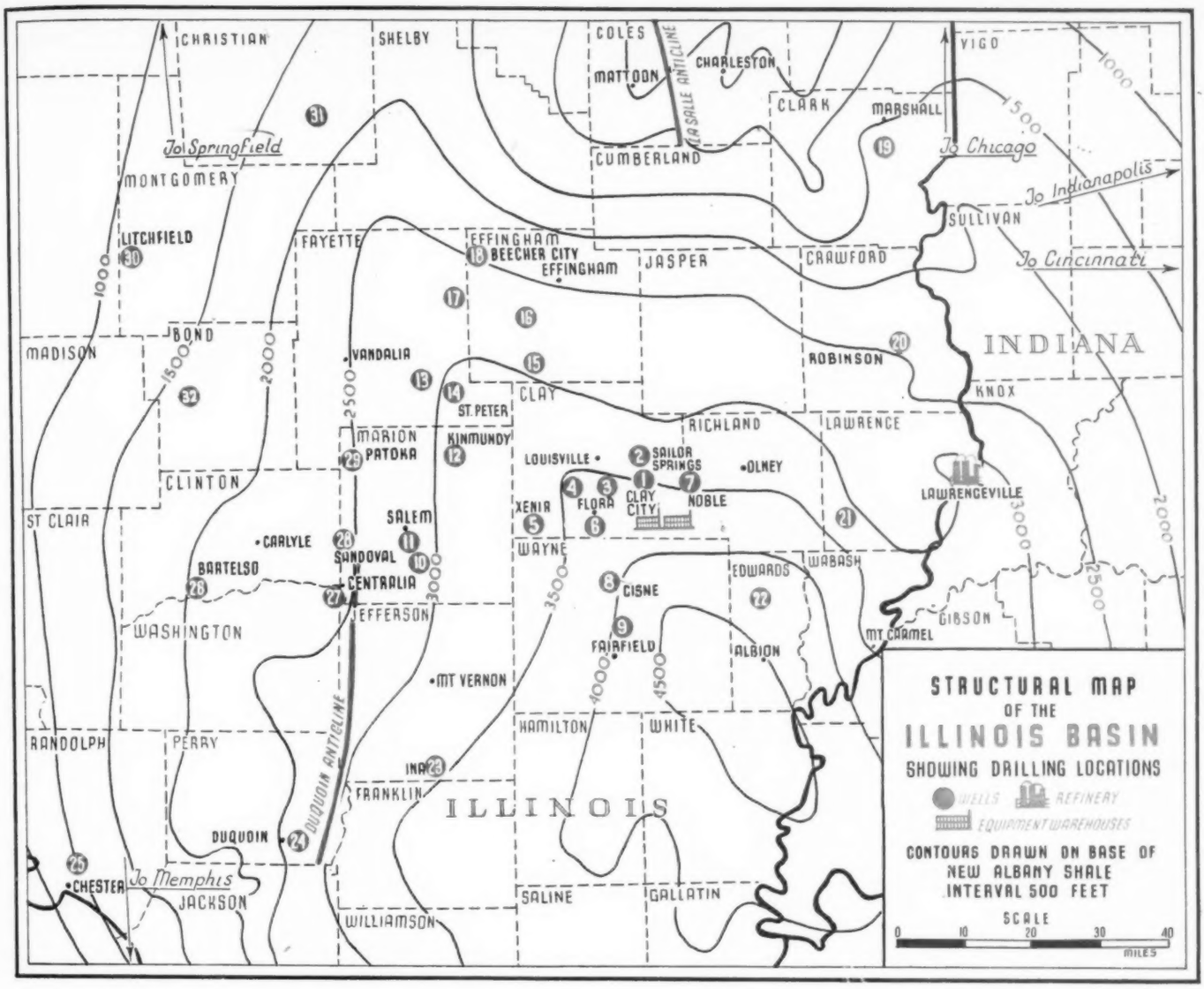
An important part of the Illinois basin was developed at the end of the Mississippian period. At this time the borders of the basin were upraised and the LaSalle antincline was folded. Deepening of the basin continued slowly and persistently throughout Pennsylvanian time and later.

The Chester or Upper Mississipian series of the Illinois area and possibly the underlying St. Genevieve limestone are represented mainly by thick beds of shaly and sandy rocks. More than half of the oil has come from sands in the Chester series.

An analysis of the geologic conditions of the Illinois area that accounts for the various productive horizons, suggests a classification into three groups. First and most important are pools in sands near the base of the Pennsylvanian system, though these are irregular in distribution and thickness; some are of the shoe-string type and occupy long narrow channels. A thinning of the Pennsylvania productive sands has been noted east of the Duquoin anticline, particularly in Franklin County, and probably extending to other intermediate areas and toward the rim of the basin proper.

Second are the Chester sands, continuous and in uniform strata for the most part, the accumulation of oil in them being dependent largely upon structure. Closed structures in these beds, particularly the Cypress and Bethel sandstones, anywhere in the Illinois basin or upon its flanks, constitute favorable sites for testing.

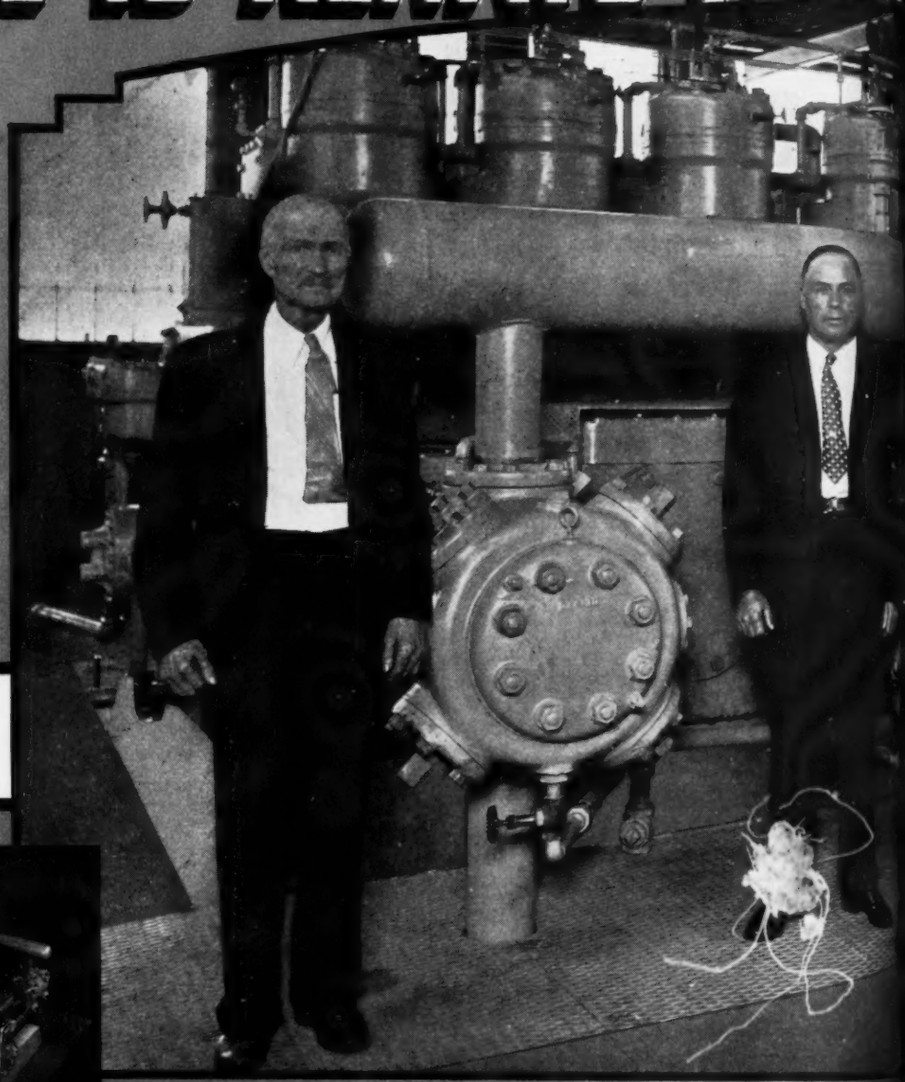
Third are the oil pools accumulated in porous limestone, said to be co-related with unconformities. Two outstanding groups of beds in which work is going on are the lenticular sandstones in the Lower Pennsylvanian system and the sandstone formations of the Chester series.



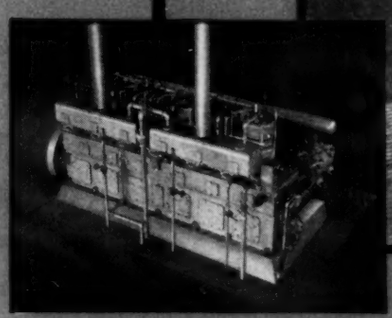
Location of Drilling and Producing Wells, Refinery, Equipment Warehouses in Illinois

Location Number On Map	Well Name	Owner	Completion Date	Depth (Ft.)	Initial Production (Bbl.)
1	Sarah Bechtel No. 1	Pure Oil Co.	19/6/37	2940-2967	1700
"	Bunny Travis No. 1	"	23/5/37	2964	3000
"	Nicholas Mosely No. 1	"	17/7/37	2889	Oil showing
"	A. Francis No. 1	"	.....	.....	Drilling
"	Bennett Mosely No. 1	"	.....	.....	"
"	Bechtel No. 2	"	.....	.....	"
"	Albert Travis No. 1	"	.....	.....	Drilling—oil showing
"	Weiler Nos. 2 and 4	"	.....	.....	Spudding in
"	Bunny Travis No. 3	"	.....	.....	Rigging up
"	Weiler No. 3	"	.....	.....	Drilling
"	Weiler No. 1	"	7/17/37	2600	Oil showing
"	Sanford No. 1	J. V. Wicklund Co.	.....	.....	Drilling
2	1 Location	Gulf Oil Co.	.....	.....	Drilling
3	1 Location	Magnolia Oil Co.	.....	.....	Rigging up
4	3 Locations	Carter Oil Co.	.....	.....	Rigging up
5	2 Locations	Benedum & Trees	.....	.....	Drilling
6	1 Location	Hiawatha Oil & Gas Company	.....	.....	Drilling
7	Brissenden No. 1	Ohio Oil Co.	.....	.....	Deep test Drilling
8	Brach No. 1	Pure Oil Co.	7/15/37	3059-3073	60
"	Stella Billington No. 1	"	7/15/37	3000	300
"	D. S. Garrison No. 1	Mamouth Prod. & Refg. Co.	.....	.....	Drilling
"	Acola No. 1	"	.....	.....	Drilling
"	C. H. Billington No. 1	Pure Oil Co.	.....	.....	Drilling
"	Bradley	"	7/17/37	.....	2800
"	Molly Mullinax	"	.....	.....	Drilling
"	Henschell Billington	"	.....	.....	Drilling
"	Carrol No. 1	Duncan Oil Co.	.....	.....	Drilling
"	Damon Smith No. 1	Wiser Oil Co.	.....	.....	Drilling
"	4 Locations	Pure Oil Co.	.....	.....	Rigging up
9	Mayberry	E. R. Washburn	.....	.....	Drilling
10	1 Location	Siegel & Schlossburg	.....	.....	Rigging up
11	Roddy No. 1	"	.....	.....	Drilling
12	Metzger No. 1	W. S. Carter	.....	.....	Drilling
13	Lilly No. 0	John Farrelly and associates	.....	.....	Drilling
14	H. W. Bhade No. 1	Rush & Milliken	.....	.....	Drilling
"	Thompson No. 1	Beaton & Ryer	.....	.....	Drilling
15	2 Locations	Kingwood	.....	.....	Drilling
16	J. Harmon No. 1	W. H. Haslett	.....	.....	Drilling
17	Bhade No. 1	Rush and Milliken	.....	.....	Drilling
18	1 Location	Kroger Grocery Co. Anheuser-Busch Brewer Co. St. Louis Baseball Club	.....	.....	Drilling
19	M. L. Jackson No. 1	National Consumers Oil Co.	.....	.....	Drilling
20					
21	Christianson No. 1	Warren Hastings	.....	1804	40
22	L. V. Lee No. 1	Leach Bros.	.....	625	Shut down
23					
24	H. H. Forrester No. 1	H. H. Forrester	.....	.....	Drilling
25	Wilson No. 1	Mabee and Associates	.....	.....	Drilling
26	C. Trame No. 1	Bartelso Oil and Gas Co.	4/18/36	1018-1036	156
26	C. Trame No. 2	"	7/10/36	1017	87
"	C. Trame No. 3	"	11/26/36	1045	32
"	Schlarmann No. 1	"	.....	.....	Moving in
"	Vandeloo No. 1	Santa Fe Pet. Corp.	7/4/36	1028-1046	128
"	Vandeloo No. 2	"	8/15/36	1065	65
"	Vandeloo No. 3	"	10/14/36	1027	77
"	Kleinkorte No. 1	"	3/14/37	1026	30
"	C. Robben No. 1	"	7/7/37	973-989	156
"	Kohrman No. 1	"	.....	.....	Drilling
"	Bergman No. 1	George Timberlake	6/15/37	1063-1071	10
"	Frank Gross No. 1	Newton & Ward	2/22/37	1015	10
"	Frank Gross No. 2	"	.....	.....	Spudded in
"	Trame No. 1	Ohio Oil Co.	12/12/36	1018-1036	87
"	Trame No. 2	"	11/14/36	997-1018	102
"	Allison No. 1	C. G. Evans	.....	.....	Drilling
"	Brammier No. 1	Ohio Oil & Gas	.....	.....	Drilling
27	Wamack No. 1	Centralia interests	.....	.....	Drilling
28	1 Location	Boyd & Smith	.....	.....	Testing
29	H. Nichols No. 1	Baldwin, Parker and Eddington	.....	.....	Drilling
"	Howell No. 1	Adams Oil and Gas Co.	.....	.....	Drilling
"	Miller No. 1	Hempen and Burgess	.....	.....	Drilling
"	City Outlot No. 1	National Consumers of Illinois	7/12/37	1425	250
"	Davidson No. 1	Adams Oil & Gas Co.	.....	.....	Drilling and coring
"	Davidson No. 2	"	.....	.....	Testing cores
"	Joliff No. 1	Hempen and Burgess	.....	.....	Drilling
"	Jeff Smith No. 1	A. J. Hausman and associates	7/12/37	1449	200
"	Perrine No. 1	"	.....	.....	Drilling
"	Adams No. 1	Cypress Oil Co.	7/13/37	1450	200
"	Alton No. 1	Frank Frederick	7/13/37	1440	Oil showing
"	Murfin No. 1	Sunflower Oil Co.	.....	1110	Shut down
"	Bachman No. 1	Ray Brown	.....	.....	Drilling
"	Wassen No. 1	Adams Oil & Gas Co.	.....	.....	Spudding in
"	Nattier No. 1	"	.....	.....	Drilling
"	Adams No. 2	Cypress Oil Co.	.....	.....	Drilling
"	Merryman Nos. 1 to 6	Adams Oil Co.	on pump	1430	100
"	Merryman No. 7	"	.....	.....	Drilling
"	Offset	"	.....	.....	Drilling
"	Jones No. 1	Claude Adams	.....	.....	Drilling
"	Lot 2	Krum and Frederickson	7/13/37	1426	150
"	"Junk Yard"	City of Patoka	6/4/37	1430	150
"	Gaultney Addition	Drilling by Hempen and Burgess	.....	.....	Drilling
"	Allison No. 1	F. Sheridan Ray	.....	.....	Drilling
"	Pete Ainscough No. 1	L. Davison	15/7/37	1467	150
"	Section 13	Patoka Petr. Corp.	.....	.....	Drilling deeper
"	Seth Martin No. 1	Weiser Oil Co.	.....	.....	Drilling
"	Brockman No. 1	"	.....	.....	Drilling
30	1 Location	Unknown	.....	.....	Drilling
31	Yockey No. 1	Parshall-Graham Oil Co.	.....	.....	Spudding in
32	Polland No. 1	Whitehead and Morey	.....	.....	Drilling

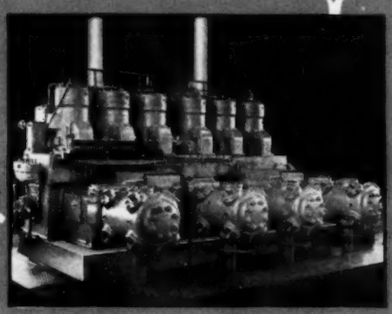
THERE IS ALWAYS A NE



4 generations representing 116 years of service in the CLARK shops. Left to right, they are Frank DeLong, 61 years of service; John



6-Cylinder Installation set up for full-load test on factory test block



New CLARK Super-2-Cycle 6-Cylinder Angle Compressor, 600 H. P.

4 GENERATIONS OF CLA
—and a *Brand*

The age and stability of the CLARK business are suggested by this unusual photograph—a family that has been with CLARK for generations. Great grandfather DeLong started with CLARK years ago. Today 4 generations of his family are employed in the CLARK shops.

CLARK BROTHERS COMPANY were pioneers in their field, and have never stopped pioneering. These men are standing in front

See CLARK Section,
1937 Composite Catalog

CLARK BROS.
COMPANY

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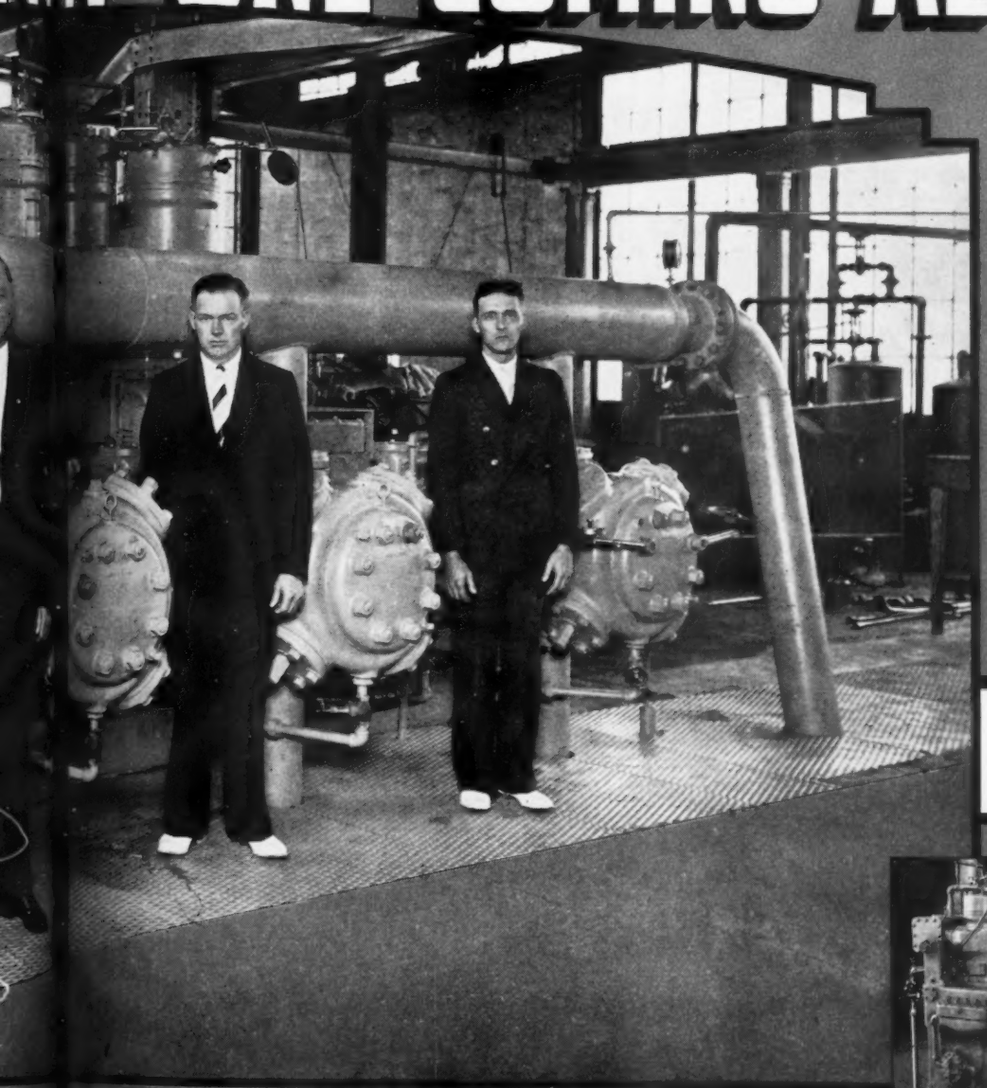
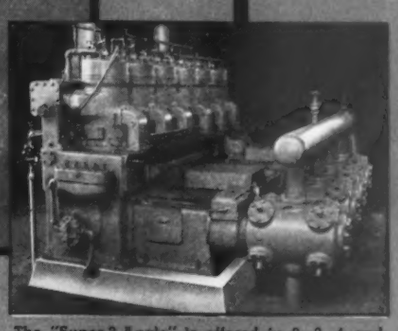
CL

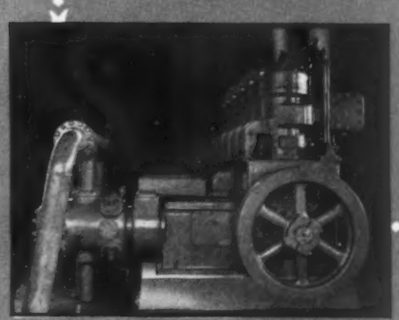
NW ONE COMING ALONG!



DeLong, son, 36 years of service; Frank Davie, grandson, 15 years; Robert Giberson, great-grand son, 4 years.



The "Super-2-Angle" is offered in 2, 3, 4 and 6-cylinder Sizes. 200 to 600 H. P.



Side View New "CLARK Super-2-Angle" in 6-Cylinder Size

WORKMEN IN ONE FAMILY
CLARK Product!

a brand new CLARK product—the CLARK Super-2-Cycle Angle Compressor in the big 600 H. P. size. The CLARK "Super 2 Angle" has introduced 5 important savings. It (1) Cuts transportation and erection costs because shipped assembled; (2) Needs smaller foundation; (3) Needs less floor space, smaller building; (4) Saves fuel; (5) Has lower maintenance costs. In the 6-cylinder size these savings will be even bigger. Write for particulars.

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Smith Casing affords this extra protection *without additional cost.* A study of the physical characteristics curves of this casing will show quickly the operating and economic advantages to the user. A special bulletin detailing these advantages and physical properties will be sent on request.

* With Smith Casing, because it has greater collapse resistance, you can

1. Use lighter weight for specified depth and maintain the present safety factor—at less cost.
2. Increase the safety factor at the same depth without increase of weight or cost.
3. Attain greater depths with equal safety.

* Because of greater compression strength, you get greater resistance to "pull-out."

* Because threads are more accurate, you get

1. Greater running speed.
2. Greater make-up speed.

A. O. SMITH CORPORATION
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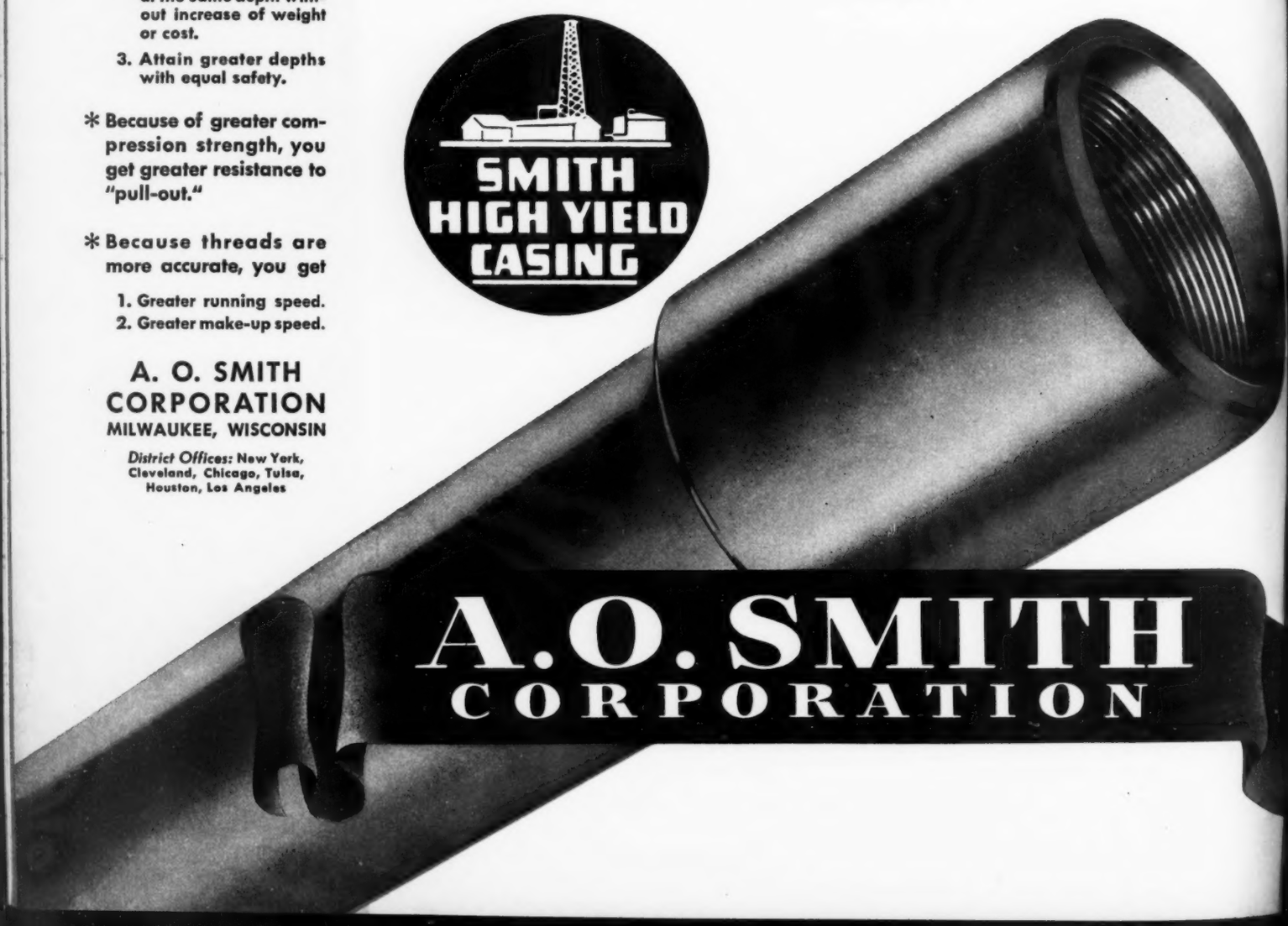

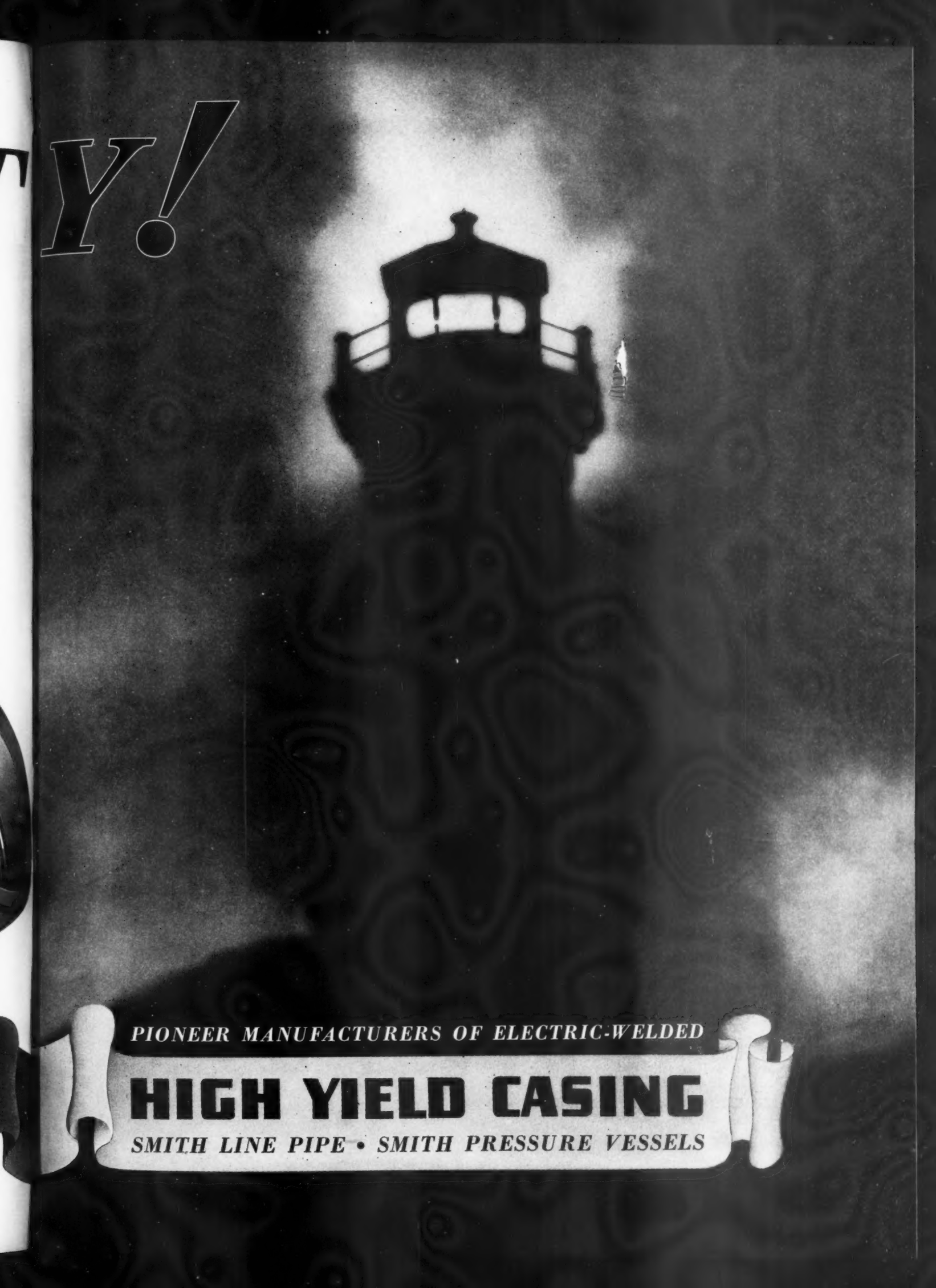
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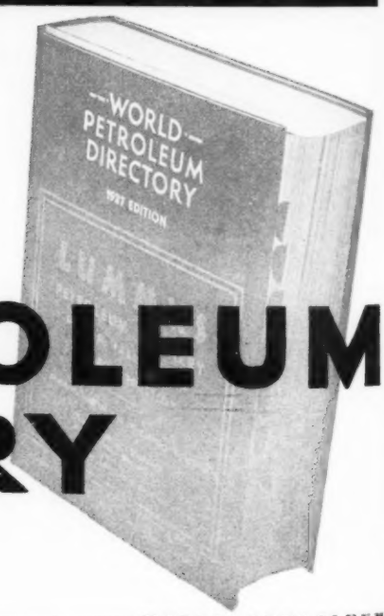


WORLD PETROLEUM DIRECTORY

56 W. 45th ST., N.Y.C. • 412 W. 6th ST., LOS ANGELES • 3 SAVOY PL., W.C.2, LONDON, ENG.

PETROLEUM BACKGROUND IN RECENT CINEMA

COLORED BY ROMANCE, "High, Wide and Handsome", latest musical production of Jerome Kern and Oscar Hammerstein 2nd, brings to life the early struggle between the powerful railroad interests and the infant Pennsylvanian oil industry.

Punctuated by rich humour, the plot concerns a young farmer (Randolph Scott) who dreams of supplying rock oil as a low-cost illuminant for city dwellers both east and west of the Alleghenies and maybe even China. On the day of his wedding—the bride (Irene Dunne) being a former member of an itinerent medicine show—his well comes in, creating the first oil boom. Primitive methods of drilling by means of spring pole are reproduced.

Daily output soon reaches several thousand barrels—drawing the attention of the railway magnate (Alan Hale) to the potentialities of this new industry, with the result that he attempts to freeze out the farmer-producers by raising freight rates beyond the economic limit. Retaliation is by construction of a cross-country pipeline to the refinery. Hale hires draymen who under the leadership of Scott's enemy (Charles Bickford) beat off the farmers with their bullwhips and tear down the line. Despite domestic troubles, Scott fights on, while Hale acquires control of a bank and as mortgage-holder on the refinery prevents extension of the time limit within which the line must be completed. Scott conceives the plan of carrying the pipe over a cliff and pumping the oil instead of building around it. Again they are attacked. Scott's wife comes to the rescue with a carnival troupe, with whose aid the draymen are beaten off, the line is completed and the oil flows through in time.

"High, Wide and Handsome" is to be recommended on all scores, and credit must be given for Paramount's reproduction of early methods of drilling and pipeline construction. A number of these scenes were based on actual occurrences in the early days of the now-great American oil industry. The setting is in a part of California which has the same appearance as western Pennsylvania, and the town of Titusville, the farmhouse, and Oxbow hill with the stream at its foot were all reproduced from early descriptions. The old wood-burning, funnel-stacked locomotive is really a museum piece. It was purchased from the Virginia and Truckee Railway, overhauled, and received a five-year operating permit.

A richly produced, spectacular and melodious show, it moves easily into the ranks of the season's best.

OUR COVER ILLUSTRATION

OUR FRONT cover picture this month shows the Ventura Avenue field in California, an important source of Tidewater Associated's production, as seen from the air. In the distance is the City of Ventura.

BRITISH OIL IMPORTS FIRST HALF YEAR

BRITISH IMPORTS of petroleum and its products during the first six months of 1937 rose by 10 percent over those of the corresponding period of last year, despite smaller receipts of crude oil and lubricants. The increase of 15 percent in gasoline imports was due to larger shipments from Iran, United States, and Netherlands West Indies. Principal increases in fuel oil receipts were from British West Indies and Iran, while in the case of gas oil the Netherlands West Indies benefited at the expense of Roumania. There was a 10 percent decrease in imports of crude oil—Iraq and Iran losing ground to Netherlands West Indies and Peru.

Relative importance of consigning countries for the half year was: Netherlands West Indies, 35 percent; Iran, 20 percent; United States, 16 percent; Roumania, 6 percent; Mexico, five percent; others, 18 percent.

British Oil Imports By Products

(Barrels)

Product	June 1937	6 Mos. to June, 1937	6 Mos. to June, 1936
Gasoline	3,926,000	20,436,000	17,609,000
Kerosene	631,000	3,087,000	2,894,000
Gas oil	531,000	2,032,000	1,676,000
Fuel oil	1,839,000	9,739,000	8,709,000
Lubricating oil	410,000	1,576,000	1,752,000
Other sorts	54,000	181,000	194,000
Refined products	7,391,000	37,051,000	32,834,000
Crude oil	1,276,000	6,935,000	7,743,000
Total imports	8,667,000	43,986,000	35,319,000

ERRATA

IN THE July, 1937, issue, in article by Claude V. Barrow—Union Drive's Slow Progress in the Oil Country—it was stated:

"Such methods have resulted in signing 26 contracts with companies in Oklahoma and Kansas since first of this year. Largest of these are the Sinclair-Prairie groups (Consolidated Oil Corp.), Shell Petroleum Corp., The Texas Corp., and Cities Service."

In this paragraph, the Texas Corporation should not have been included.

GULF EXPORT PRICES FOR MAJOR OIL PRODUCTS

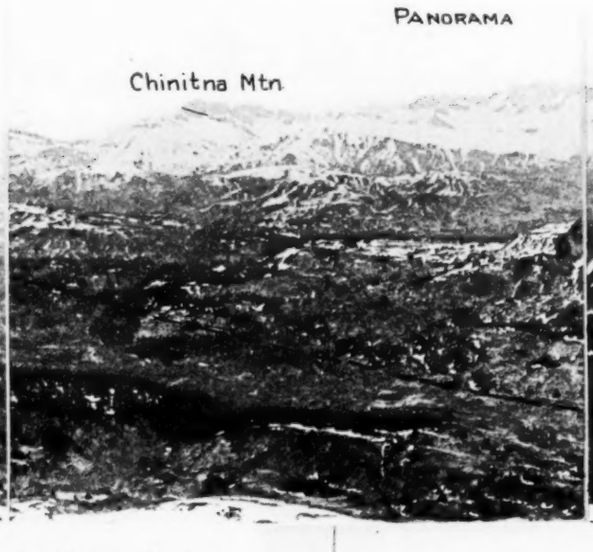
	Products	Cents per Gallon			
		June 16	June 23	June 30	July 7
GASOLINE:	U. S. Motor	5⅞	5⅞	5⅞	6
	64/66-375 E.P.	6¼	6¼	6¼	6⅜
	59 Octane & below	6	6	6	6
	65 Octane & above	6½	6½	6½	6½
AVIATION GASOLINE: (Based on last actual transaction)	Gulf Export cargo lots	9	9	9	9
KEROSENE:	44 w.w.	5	5	5	5
	41/43 w.w.	4¾	4⅞	4⅞	4⅞
	41/43 p.w.	4¾	4⅞	4⅞	4⅞
GAS OIL:	26-30 translucent	3⅞	4	4	4
	30 plus translucent	4	4⅛	4⅛	4⅛
FUEL OIL	Bunker C. (per bbl.)	$1.05	$1.05	$1.05	$1.05
	Cargo lots (per bbl.)	.95	.95	.95	.95
	Diesel oil (per bbl.)	1.90	1.90	1.90	1.90
LUBRICATING OIL:	Bright Stock No. 8	32½	31½	31½	30½
	Bright Stock No. 6½	32	31	31	30
	600 Warren E	26½	26½	26½	26
(New York Export Market)	600 Unfiltered s.r.	24½	23½	23½	23
	650 Unfiltered s.r.	26½	26	25½	25
	600 Flash s.r.	27½	27	26½	25½
	630 Flash s.r.	31½	31	30½	30
	Neutral 200 No. 3	35	34½	34	33
	Neutral 150 No. 3½	30½	30	29½	28½
(South Texas Export Market)	Red oil 500 No. 5-6	7	8½	8½	8½
	750	8¾	9¼	9¼	9¼
	1200	9½	9¾	9¾	9¾
	Pale oil 500	7⅝	8½	8½	8½
	750	8¾	9½	9¼	9¼
	1200	9½	9¾	9¾	9¾
CRUDE OIL:	East Texas delivered at Gulf port for export (per bbl.)	$1.57	$1.57	$1.55	$1.55
	Venezuela (per bbl.)	1.30	1.30	1.30	1.30
	Trinidad (per bbl.)	.90	.90	.90	.90
	Panuco (per bbl.)	1.35	1.35	1.35	1.35

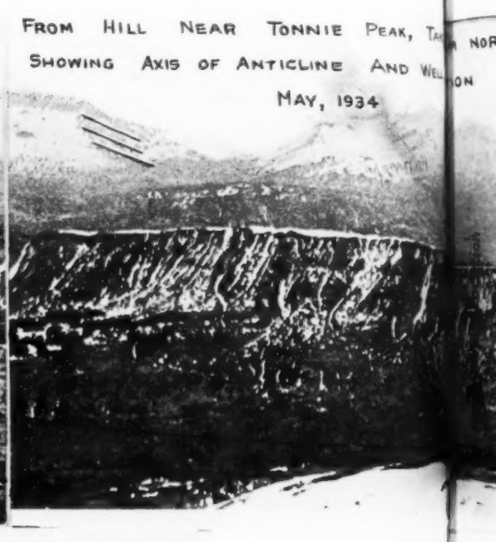
FREIGHT RATES

	Dirty	Clean	Dirty	Clean	Dirty	Clean	Dirty	Clean
	Shillings per ton							
Gulf—U.K./Continent	30/-	30/6	31/-	31/-	29/-	29/-	28/6	27/6
California—U.K./Continent	no booking						32/-	34/6
Aruba—U.K./Continent	27/6	27/6	27/6	28/-	24/-	26/-	24/-	26/-
North Atlantic—U.K./Continent	27/6	29/-	27/6	29/-	27/-	27/-	23/-	24/6
	Cents per Barrel							
California—North Atlantic	no booking							
Gulf—North Atlantic	55	57	55	57	54	60	52½	60
Venezuela—North Atlantic	55	—	55	—	49	—	—	—
Tampico—North Atlantic	62	—	60	—	53	—	53	—

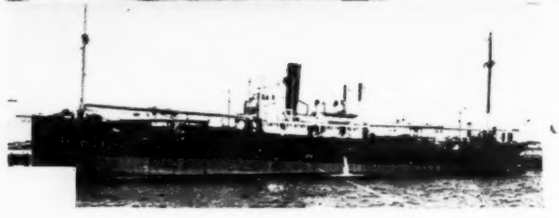
ALASKAN WILDCAT RESUMES DRILLING

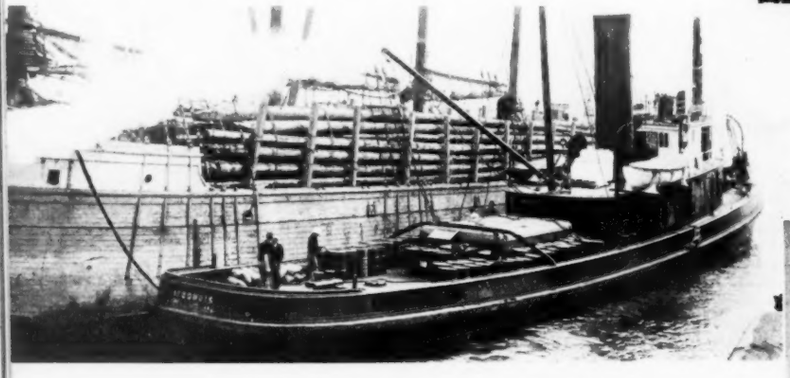
After exploring the Iniskin-Chinitna Peninsula, Alaska, a few years ago, Russell Havenstrite and Carl Beal, Los Angeles oil men, sent an expedition to study the geology and survey for road construction. Supplies were sent up in June, 1936, unloading being completed by August 17th and a test well was spudded September 7th. By November 3rd 2,540 ft. of hard sandstone and grey shale had been drilled, at which time activities ceased due to fuel shortage and approach of winter. It is hoped that the first test will be completed this year.





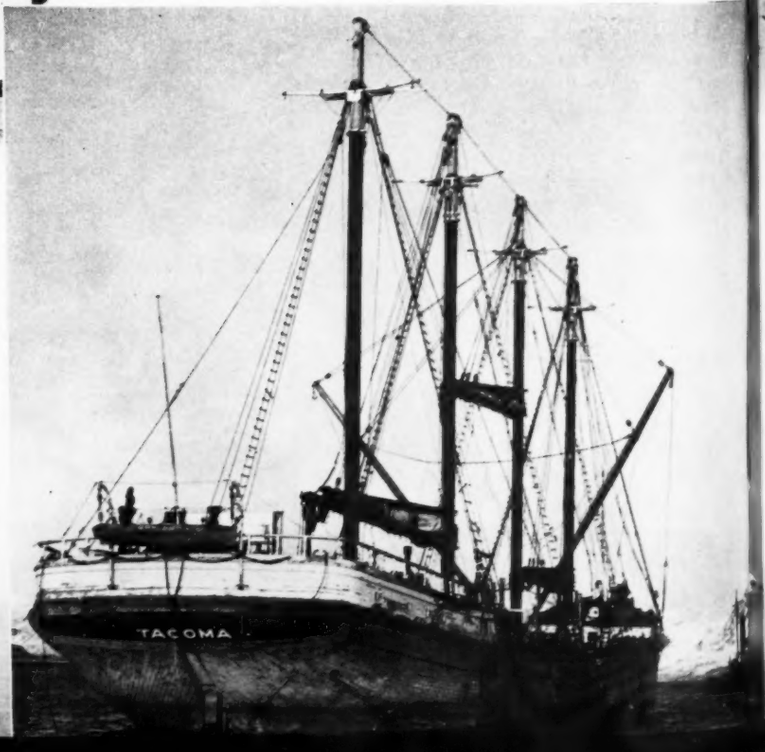
Iniskin Drilling Company's wildcat is located on a 12-mile anticline not far from Oil Bay. Certain shallow wells drilled in the vicinity many years ago were credited by U.S.G.S. with a 50 bbl. daily output. Prepared to go to 7,500 ft., the company hopes that production will be found in the Jurassic at 5,000 ft.





Early in May of this year preparations were started to resume drilling. Since more fuel oil was needed at the location the "Commodore," a 233 ft. sailing vessel, was purchased to carry 5,000 drums of oil and other supplies. It was towed by a 1,200 h.p. tug.

A 3,500 ton freighter, re-named "Iniskin," was also purchased to carry the necessary derrick and equipment, which included $17,000 worth of rock bits, 11,000 bbl. of fuel oil for firing boilers, 10,000 gal. of gasoline and Diesel oil for the tractors, lighters and 60 ft. power cruiser—ship and cargo cost $300,000.



The "Commodore" arriving at Chinitna Bay in tow of the tug "Iroquois."

Motor launch "Mardo" snowed in at Chinitna Bay.

The camp at the well site has a doctor, and is laid out complete with bunk house, machine shop and field hospital.

When the crew arrived after winter shutdown it was discovered that five feet of snow remained on the ground (see pictures below and right), rendering useless the six mile road built the previous summer from the coast to the well. When the ship had been unloaded the road was still unpassable, and the tractors had to be dug out.

CZECHOSLOVAKIAN Oil Industry Prospers

By Jule B. Smith*

IMPROVEMENT in Czechoslovakia's economic conditions in general, and upward trend in industrial activities in particular, which continued at an accelerated rate throughout 1936, has brought about an increasing demand for mineral oils.

Due to insufficient domestic supplies of crude oil, Czechoslovakia must import large quantities of crude and semi-manufactured products. The steady price advances on the world petroleum markets during 1936 were intensified for Czechoslovakian mineral oil refiners by 16 percent devaluation of the Czechoslovak crown on October 10, 1936. However, they succeeded gradually in adjusting domestic prices of mineral oils to the world price level, with the exception of the gasoline-alcohol motor fuel mixture which still leaves an insignificant margin of profit.

The principal 11 Czechoslovakian refineries have an annual capacity of some 2,940,000 bbl. A new mineral oil refinery has been under construction in Dubova, province of Slovakia, which is owned by the government and is to process crudes from state-owned oil wells at Gbely.

In addition to refining crudes, all Czechoslovakian refineries process large quantities of imported semi-refined mineral oils and their annual capacity for refining such products is said to be somewhat in excess of 4,900,000 bbl.

Refineries in Czechoslovakia are owned largely and controlled by international capital. Capital holdings in order of importance are: Austrian, French, American, Czechoslovakian, Polish and Dutch.

The first cracking plant in Czechoslovakia was constructed by "Apollo" Mineraloelreffinerie A. G., in their Bratislava refinery. Equipment was manufactured under American patents and delivered by Skoda Works Company, of Prague, at a total cost of 10,000,000 crowns ($348,000). The company also installed a new pipe still. Unsteady market conditions, the fact that capacity of local plants is more than sufficient to cover domestic needs, and anticipation that competition on the domestic market will become keener after the state-owned refinery is put into operation, worked as a check on new outlays.

The cartel agreement which was concluded in June, 1931, for the purpose of regulating sales and prices of mineral oils in Czechoslovakian territory, was subscribed to by eight companies operating twelve refineries and expired on December 31, 1936. The agreement was extended to June 30, 1937, with two amendments: the Priemyselna a Obchodna Ucastinna Spolecnost, Strazske, province of Slovakia, which owns a small refinery processing only semi-refined oils, has become an outsider; and it prohibited customs refining for firms other than cartel members and participation of cartel members in any competitive concern.

Priemyselna a Obshodna U. S., and its sales organization Tatra-Nafta Company, were purchased in February, 1937, by Julius Ruetgers, Moravska Ostrava, the most important Czechoslovakian benzol producer. The transaction is important because the firm Ruetgers is controlled by two outstanding Czechoslovakian mining and iron and steel concerns and has acquired through the purchase an oilfield in Mokova, northern Slovakia, the only area in Czechoslovakia yielding oils containing (about 40 percent) gasoline. This output has been negligible as the former owner did not have sufficient financial means to drill deep wells, but it is anticipated that drilling to greater depths may increase the yield substantially. This field is only 15 kilometers from the richer oilfields in Poland.

Out of the 1936 total output of 130,655 barrels of crude petroleum, the state-owned oil wells in Gbely (Slovakia) accounted for 82,461 barrels, the oil wells at Hodonin (southern Moravia) of the "Apollo" Company for 48,041 barrels while the Mikova oilfield in northern Slovakia yielded only 133 barrels.

Decline in Czechoslovakian crude petroleum production by 39.1 percent, is attributed principally to decreased output at Hodonin wells because the "Apollo" Company refrained from drilling owing to heavy taxes imposed on capital investments made for this purpose. Since the company recently succeeded in obtaining a reduction in these taxes, it is expected that the production will rise again.

Czechoslovakian refining industry depends on outside sources of supply for more than 80 percent of local requirements. During 1936 imports of crude petroleum from Roumania continued to increase and represented 62.6 percent of the total, due to specific importance attached to Roumanian mineral oils on the basis of the Czechoslovakian-Roumanian clearing agreement. Shipments of crude petroleum from the United States into Czechoslovakia dropped by 49.8 percent in 1936. The third important source of supply was Colombia, whose exports gained 121.7 percent.

Czechoslovakia has no domestic supply of gasoline worthy of note and must import motor fuel to satisfy its domestic consumption which is estimated at almost 200,000 metric tons per annum. There has been an obvious tendency to restrict imports of refined gasoline and encourage crude imports so as to ensure better operation of domestic refineries.

Roumania and Poland were Czechoslovakia's only suppliers of crude gasoline in 1936, the first having shipped 72.6 percent and the latter 27.3 percent of total imports of the unrefined product. Roumania dominated the refined gasoline market.

Heavy mineral oils, refined or semi-refined, having a specific gravity of more than 880 deg., which are imported into Czechoslovakia are chiefly of United States origin and include principally lubricants such as machine oils, turbine oils, cylinder oils and automobile oils. They are imported either direct or indirect via Hamburg and Germany. Approximately 90 percent of Hamburg trans-shipments are from the United States. In addition, imports of heavy mineral oils from Germany include certain quantities of heavy oils from the United States and certain quanties of the Royal Dutch-Shell product, but no oils of German make because the German Government inflicted an embargo on products refined in that country.

During 1936, the United States supplied direct approximately 73.3 percent of total Czechoslovakian heavy mineral oil imports.

Czechoslovakian inbound shipments of light mineral oils with a specific gravity of less than 880 deg. came mostly from the United States in 1936 and consisted principally of light lubricants, machine and automobile oils, spindle oils and transformer oils. Second largest supplier was Germany, but it is maintained that shipments from Germany were mostly re-exports of Shell's oil and products of United States origin owing to the German embargo. Total imports of light mineral oils decreased 30 percent, and the United States was the only country which increased her supply of these oils—having shipped 69.8 percent more in 1936 than in the preceding year.

By a notice of the Czechoslovakian Minister of Finance, dated May 22, 1937, the import lump-sum turnover tax on mineral oils was increased substantially effective June 1, 1937.

Lump-Sum Turnover Tax

Product:	Present (Czechoslovak Crowns per 100 Kilos. Net)	Former (Czechoslovak Crowns per 100 Kilos. Net)
Gasoline	27.00	20.50
Kerosene	21.00	12.00
Gas oil	9.00	9.00
Lubricating oils	36.00	19.50

Prospects for the Czechoslovakian oil market in 1937 are considered much more optimistic than 1936. If the present upward tendency in industrial development continues further substantial increases in domestic consumption of mineral oils may be expected. Local experts even expressed the opinion that a gain of 10 percent in gasoline consumption and of 14 percent in the consumption of lubricating oils might be easily anticipated under present conditions. This, of course, would result in much heavier purchases of crude and mineral oil products by Czechoslovakia abroad.

*By courtesy of U. S. Department of Commerce.

CZECHOSLOVAKIAN STATISTICS

Area: 140,400 sq. km. Population (1935 est.): 15,090,000. Inhabitants per sq. km.: 107.

Principal industries: Sugar, alcohols, textiles, shoes, leather goods, glass, china, coal, iron, machinery, chemicals, paper, and cement.

Railways: length, 13,486 km.; locomotives, 4,229; passenger carriages, 9,431; freight cars, 95,396. Traffic (1936): passenger kilometers, 6,845,700,000; freight kilometers, 7,277,500,000; passengers, 237,600,000; freight, 615,400,000 tons.

Roads: State, 8,656 km.; provincial, 6,618 km.; district, 46,566 km.; others 7,634 km.

Motor vehicles (1935): passenger cars and taxis, 83,611; buses, 3,855; trucks, 29,173; motorcycles (1934), 45,700.

Air traffic: liner planes (1935), 34; civilian planes (1935), 150; route mileage, 2,268; miles flown, 613,806; passengers carried, 13,138; passenger miles, 2,183,703; mail carried, 18 tons; mail ton-miles 2,606; freight carried, 415.3 tons; freight ton-miles, 66,351.

Length of navigable waterways: for steamers, 469 km.

Retail oil prices and taxes (U. S. cents per gallon): Alcohol-gasoline mixture, price including duty of 4.9 and tax of 9.7: at Prague, 49.2; Brno, 50.6; Bratislava, 49.9. Aviation gasoline, wholesale price (including duty of 7.0 and tax of 11.7): at Prague, 41.3; Brno, 40.8; Bratislava, 40.4. Kerosene, price (including duty of 5.8 and tax of 5.5): at Prague, Brno and Bratislava, 28.9. Lubricating oil, price (including duty of 10.3 and tax of 9.2): at Prague, Brno and Bratislava: No. I, 223.6; No. II, 119.1; No. III, 84.2. The above prices were in effect January 1. 1937.

CRUDE OIL AND NATURAL GAS PRODUCTION 1932-1936

Year	PETROLEUM Barrels	NATURAL GAS Cubic Meters
1932	129,451	900,651
1933	124,432	1,159,319
1934	181,797	1,205,414
1935	139,622	1,372,169
1936*	130,655	1,298,328

* Preliminary figures.

PRODUCTION OF REFINED OIL PRODUCTS 1933-1936

PRODUCT	1936	1935	1934	1933
	Barrels			
Gasoline	1,281,000	1,158,500	1,115,800	1,103,900
Kerosene	560,000	532,000	514,500	490,700
Gas oil	220,500	220,500	237,300	176,400
Lubricating oil	161,000	163,100	176,400	161,000
Paraffin wax	34,300	37,100	31,500	33,600

CONSUMPTION OF PETROLEUM PRODUCTS 1933-1936

PRODUCT	1936	1935	1934	1933
	Barrels			
Gasoline	1,393,000	1,319,500	1,260,000	1,267,000
Kerosene	584,500	542,500	528,500	515,900
Gas Oil	210,000	201,600	203,000	183,400
Lubricating oil	318,500	290,500	291,900	282,800
Paraffin wax	42,000	37,100	37,800	35,000

PETROLEUM IMPORTS 1935 AND 1936

	1936	1935
CRUDE OIL:	Barrels	
Roumania	712,747	516,957
United States	251,748	501,095
Colombia	173,845	78,428
Others	7	Nil
Total	1,138,347	1,096,480
GASOLINE, REFINED:		
Roumania	154,317	156,034
United States	5,720	3,927
Esthonia	1,623	1,368
Others	664	689
Total	162,324	162,018
GASOLINE, UNREFINED:		
Roumania	999,039	908,531
Poland	376,125	323,204
Others	Nil	17
Total	1,375,164	1,231,752
KEROSENE:		
Roumania	10,199	11,825
Others	8	1,738
Total	10,207	13,563
OTHER MINERAL OILS: (790-880 deg.):		
United States	8,682	5,113
Germany	7,899	9,819
Hamburg (transit)	617	1,913
Roumania	489	7,809
Others	611	1,505
Total	18,298	26,159
PETROLEUM DISTILLATE:		
Roumania	139,897	132,616
Poland	134,229	170,711
Others	7	15
Total	274,133	303,342
LUBRICATING AND OTHER HEAVY MINERAL OILS:	Barrels	
United States	75,492	73,087
Germany	16,162	6,384
Hamburg (transit)	5,072	9,577
Russia	3,911	4,892
Others	2,322	2,274
Total	102,959	96,214
OIL DISTILLATE:		
Poland	13,426	15,796
Others	Nil	7
Total	13,426	15,803
PETROLEUM AND STEARIN PITCH:		
Mexico	9,518	7,899
Germany	4,296	6,116
Great Britain	2,102	54
United States	594	983
Roumania	281	419
Others	240	1,938
Total	17,031	17,309
LIGNITE AND SCHIST TAR:		
Total	89	124
ASPHALT:		
Total	1,235	1,405
PARAFFIN:	Pounds	
Total	982,984	2,909,280
PETROLATUM:		
United States	403,332	299,744
Others	74,936	116,816
Total	478,268	416,552
AXLE GREASE CONTAINING MINERAL OILS OR GREASE:		
Total	290,928	199,242

PETROLEUM EXPORTS 1935 AND 1936

	1936	1935
CRUDE OIL:	Barrels	
Total	12	Nil
OTHER MINERAL OILS: (790-880 deg.):		
Total	1,604	129
LUBRICATING AND OTHER HEAVY MINERAL OILS:		
Germany	8,617	11,746
Others	3,468	1,348
Total	12,085	13,094
PETROLEUM AND ANIMAL FAT:	Metric Tons	
Total	132	168
LIGNITE AND SCHIST TAR:		
Germany	5,867	6,665
Others	83	244
Total	5,950	6,909
ASPHALT:		
Total	17	23
PETROLATUM:	Pounds	
Total	1,102	2,204
AXLE GREASE CONTAINING MINERAL OILS OR GREASE:		
Total	3,747	26,448

Foreign Oil Legion

D. E. BUCHANAN and E. I. HANLON, of Hanlon-Buchanan Inc., Tulsa, Oklahoma, were granted an interview by Premier BENITO MUSSOLINI on their recent visit to Italy. They were also granted an audience by His Holiness, POPE PIUS XI. The two partners spent the next fortnight visiting

D. E. Buchanan

the refining centres of Europe. Mr. Buchanan was chairman of the official United States delegation representing the American Petroleum Institute at the Second World Petroleum Congress.

R. H. MORRISON, of the California Texas Oil Company, returned to New York from a prolonged visit to the Near and Middle East late in July, subsequently taking a plane August 3rd for San Francisco. Dick Morrison, who also informed the representative of this journal that he made first-hand observations of the production activities of Iraq Petroleum Company Ltd. and Anglo-Iranian Oil Company Ltd., was greatly impressed by the progressive operations of those two concerns and says that America has much to learn from them. The latter oil company has been experimenting for some time with the return of fuel oil and other refinery surpluses to the ground, which he reports to be entirely successful. It depends upon local conditions as to whether this plan would be feasible for other producing areas —in this case the limestones are highly fractured— but no doubt this experiment will have its reflections in other fields. These companies have two of the finest producing organizations he has seen anywhere in the world, Mr. Morrison states; organizations which his company hopes to equal at Bahrein.

To-date the drilling in Eastern Saudi Arabia has been to comparatively shallow depths. A deep test has been commenced at Damman, but not yet at El Elat.

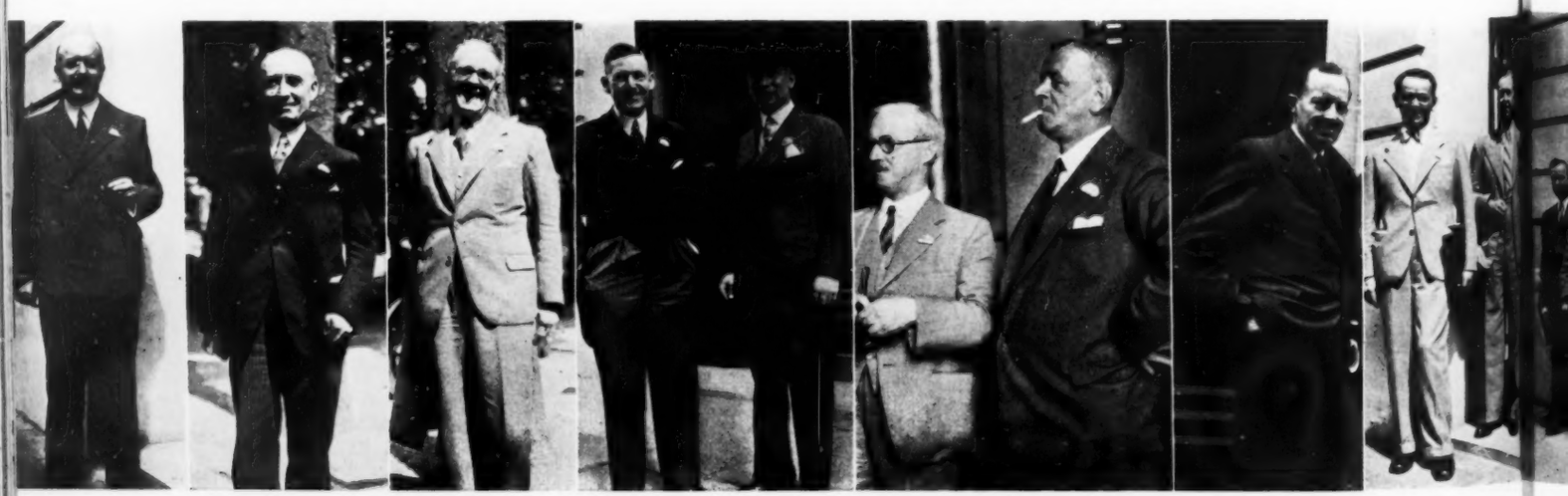
The Bahrein field has at present about 40 producers. Drilling has been temporarily slowed down pending the completion of studies to determine optimum spacing and which type or types of repressuring the company will utilize. The Bahrein encampment is a very interesting place from the point of housing facilities in addition to being an up-to-date producing and refining centre. A series of 36 air-conditioned houses are being satisfactorily tried out—the climate is humid, with temperatures of from 110 to 115 deg. F.

Mr. Morrison was greatly impressed, quite apart from the oil industry, with the rapid progress made by Iraq and Turkey in modernising the respective countries, both industrially and socially, to a point comparable with civilization in western Europe. He reports that he found better railway trains on the Taurus Express through Turkey than on some of the important routes through Europe. Bazra, gateway to Iraq and the place whence Sinbad the Sailor started his voyagings, is a fine port with the most modern facilities.

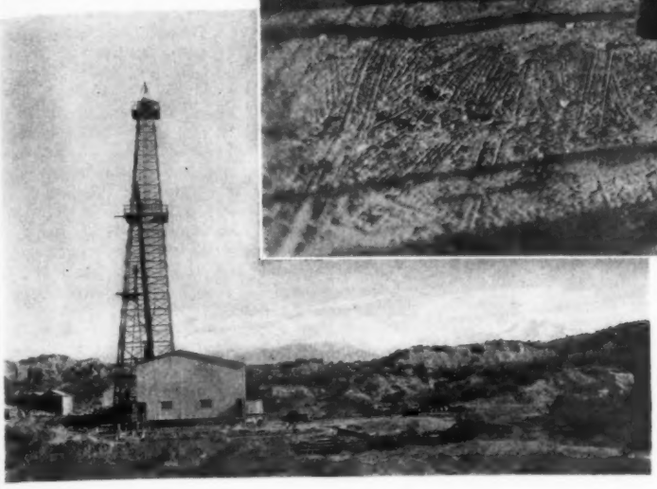
JOHN M. LOVEJOY, president of Seaboard Oil Company, Amiranian Oil Company and Inland Exploration Company, sailed from New York with his family July 18th, for a month's vacation in Europe. After touring England he proceded to Austria where he attended the Salsburg Music Festival, and will return to the United States by way of France.

LINN M. FARISH, in charge of the drilling program of Amiranian Oil Company, is attending the International geological Congress at Moscow, whence he will go to Iran early in September on a tour of the prospective northern oilfields of his company. Mr. Farish will also visit Afghanistan to look at certain sites in the concession of Inland Exploration Company.

Many widely-known oil men attended the Second World Petroleum Congress held in Paris, June 14th to 19th, 1937. From left to right: Ch. Bihoreau, of the French Petroleum Department, President of the Congress; Col. Louis Pineau, power behind the French oil industry; Maurice Mercier, Cie. Francaise de Petroles; Col. Sammy Auld, Vacuum Oil Company Ltd., president of the I. P. T., with A. Clifford Hartley, Anglo-Iranian Oil Company Ltd.; both prominent in their fields; James Kewley, Asiatic Petroleum Ltd.; and his fellow chemist, Dr. A. E. Dunstan, Anglo-Iranian Oil Company Ltd.; Chas. W. Wright, U. S. Bureau of Mines; and Nic. N. Stefanescu, president of "Aquila" Romano-Americana, with M. Metsch of "Unirea."



Right: Carlos Fernandez, petroleum engineer, and J. Messone, chief engineer in charge of drilling and production, at Mendoza field of Yacimientos Petroliferos Fiscales, Argentine Government oil company. Below: Outlined against the snow-covered Cordillera's is the Y. P. F. Diesel rig, Tupungatu No. 10, on which they are working.



ROBERT H. RICHARDS, for the last ten years oil editor of the Wichita Beacon has joined the staff of Rinehart's Oil Reports and has been placed in charge of the Kansas office of that extensive service. Rinehart's Oklahoma and Texas daily reports on drilling have been well known in the industry for a number of years. The weekly Kansas report was started last year. Mr. Roberts will devote himself to improving the service rendered to the industry by the Kansas division of Rinehart's.

F. M. GILSTRAP, production superintendent at El Centro for Tropical Oil Company, is expected to leave the United States on his return to Colombia late in September or early October.

C. S. PENFIELD recently returned to the United States to take up his duties as drilling superintendent for Shell Oil Company at Signal Hill. He had previously served in that capacity for 18 months with Sarawak Oilfields Ltd., at Miri.

DR. HUBERT G. SCHENCK has leave of absence from Stanford University for the purpose of making paleontological studies in the Iranian and Afghanistanian concessions, reported to contain a number of highly promising geological basins. Amiranian Oil Company and Inland Exploration Company recently obtained drilling and exploitation concessions for these areas. Dr. Schenck has been retained by these companies for a year.

JOHN B. MEHERIN, field manager for British Burma Petroleum Company Ltd. at Yenangyaung, is home on vacation leave and may be reached at 4616 Shaw St., Long Beach, California. He is expected to return to Burma in October.

C. R. SMITH has been appointed drilling superintendent for Oil Search Ltd. and is at present bound for Sydney, Australia. He recently returned to Los Angeles from Portuguese East Africa where he was in the employ of Inyaminga Petroleum Company Ltd.

Others at the Congress included: F. W. Hall, director of research, and W. Gee, technical director, of The Texas Corporation, with Dr. N. L. Anfilogoff, European technical services, of Texas Oil Company Ltd.; A. Beeby Thompson, geologist of world-wide reputation; A. P. Catherall, who advised the Iraq Government on its proposed refinery; and Prof. Kozaburo Kurihara, Akita Mining College, Prof. Yoshio Tanaka, Imperial University (Tokyo) Engineering College, and Shingo Ando, Imperial Fuel Research Institute.

A. L. Guiselin, Cie. Industrielle des Petroles, a most active congressionalist despite his venerable appearance.

WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing With Technical and Economic Aspects of the Petroleum Industry. Edited by Dr. O. W. Willcox

PETROLEUM GEOLOGY

THE ILLINOIS BASIN—J. Marvin Weller and Alfred H. Bell, in BULL. AM. ASSOC. PETROLEUM GEOLOGISTS, vol. 21 (1937), No. 6, pp. 771-788 (6 figs.).

I. STRUCTURAL HISTORY—The Illinois basin is part of a larger basin which during Paleozoic time extended an unknown distance southward. The greater part of the relative uplift of the borders of the Illinois basin probably occurred at the close of the Paleozoic era (Appalachian evolution). Major and minor structures within the basin were formed at various times during the Paleozoic era; much deformation along the southern border of the basin was of post-Paleozoic age. The time of origin of the more important known structures in the basin is discussed.

II. EXPLORATION FOR OIL—The history of oil exploration in Illinois is briefly reviewed with special attention to the great southeastern Illinois field which ranks sixth in total production to date in the United States. During most of the 32 years following discovery of this field there has been little systematic exploration for oil in Illinois, but this has been due in large measure to belief that oil production is probable only around the rims and not in the central portions of large structural basins. Discovery of the Mt. Pleasant field in Michigan and numerous fields in West Texas and elsewhere has upset this belief, so that now many geologists and oil executives favor careful exploration for oil throughout the areas of large structural basins. Possible oil-producing formations in the Illinois basin and structural trends in the basin with relation to oil possibilities are discussed.

Since 1934 the central part of the basin has been explored scientifically by both geological and geophysical methods. The first discoveries following the recent activity have come in 1937; three new oil wells, all located on the basis of seismograph surveys, and two of which are in the deep basin area, appear to be the beginning of a new period of development.

STRATIGRAPHY OF THE SUNDANCE (WYOMING) FORMATION AND RELATED ROCKS AND THEIR PETROLEUM ASPECTS—Joseph Neely, in BULLETIN AM. ASSOC. PETROLEUM GEOLOGISTS, vol. 21 (1937), No. 6, pp. 715-770 (13 Figs.).

Evidence exists that the Nugget formation may be equivalent to the thick basal sandstone within the Sundance formation in the vicinity of the Freeze-out Hills, southeastern Wyoming; that the Twin Creek formation is in part equivalent to the Ellis formation of northwestern Wyoming, and to the lower portion of the Sundance formation in central and eastern Wyoming; that there is an erosional interval within the Sundance formation, and that this erosion period corresponds with the time of withdrawal of the Twin Creek sea; that the upper portion of the Sundance formation is equivalent to the Preuss and the stump formations of western Wyoming and southeastern Idaho and to the upper portion of the Ellis formation of northwestern Wyoming, or the Sundance formation as it has been redefined by Crickmay. The writer has attempted an explanation of the occurrence of red beds and gypsum within the Sundance formation. It is believed that these red beds were deposited, in part at least, in inland lakes and undrained depressions immediately after the retreat of the Twin Creek sea and during the erosion period which followed, and in part in the marginal lagoons and bays of the retreating sea.

The economic portion of this paper is intended to point out the areas, depth, initial production, and quality of the oil from the Sundance formation. The distribution of Sundance fields is striking. The important Sundance fields lie in a broad belt which parallels the shore line of the Twin Creek and Logan (Sundance) seas. Theories which appear to be in part applicable to such an accumulation are: Existence of paleo-biochemical conditions associated with the shallow-water near-shore deposits which controlled the abundance of petroleum-forming organisms; migration of petroleum up the initial dip of the Sundance sediments before the folding during late Cretaceous time; and porosity control by the coarser-textured sandstones deposited near the shore.

Southeastern Wyoming is in general an area of high hydrostatic pressure and "water flushing" has undoubtedly played no small part in local accumulations of oil, and is perhaps the reason for its absence from certain well defined structures where it would *a priori* be expected. The lower Sundance is apparently a stratigraphic trap.

GEOPHYSICS

AMOUNT AND DISTRIBUTION OF SEISMIC AND GRAVITY EXPLORATION IN THE GULF COAST THROUGH 1936—E. E. Rosaire and K. Ransone, in GEOPHYSICS, vol. 2 (1937), No. 1, pp. 1-16.

Maps are presented showing the accumulated density of exploration by the reflection seismograph and the torsion balance for 114 counties and parishes comprising the Gulf Coasts of Texas and Louisiana. The data have been compiled from records and reports of the exploratory operations of seven oil companies. During the past six years the total expense for both forms of exploring has been something over $22,000,000, about $8,500,000 has been spent in 12 counties and parishes. The average cost of geophysical surveying is about ten cents an acre.

The authors bring out the fact that in making their own coast-wide surveys the different company operations show considerable overlapping. For the present much of this excess work remains unfruitful, due to the fact that existing methods are not yet sensitive enough to detect all possible deposits of oil. However, if the future should develop methods of greater finding power, the available records by the old methods could be quickly tied in with the new information. For this reason those companies that have contributed materially to conspicuous overruns of exploration may be said to be building up libraries of geophysical data against the time of the appearance of new developments.

A RESEARCH LIBRARY IN THE GEOPHYSICAL FIELD—James B. Macelwane, in GEOPHYSICS, vol. 2 (1937), No. 1, pp. 17-20.

The author advocates the establishment of a special library where the rapidly accumulating geophysical data might find a permanent resting place. Much of this material is obsolete but still of value to research workers, and its deposition in a library would entail no loss to the owners. Reasons for establishing such an institution are summed up.

Creation of a geophysical research library of the type described will preserve from ultimate destruction original records and data of inestimable scientific value that, once lost, will never be replaced because of the cost. Such a library will provide the opportunity to geophysical prospecting units of securing in one place and under the most favorable conditions all the public information available on an area before going into it. The library will itself add greatly to geophysical knowledge, for the correlation and evaluation of records and documents will bring out new facts and scientific relationships. Presence of the library and the challenge of its problems in a university atmosphere with a background of pure science will greatly stimulate the broader research activities of the whole geophysical institute of which the library should form a part. To secure the best results, the location should be central with reference to the whole country, and the staff must be above all suspicion of favoritism toward any particular interest or commercial concern.

(Note—The editors of WORLD PETROLEUM are happy to endorse the proposition, with the hope that interested parties will soon perceive the wisdom of it.)

RECENT DEVELOPMENTS IN GEOPHYSICS IN THE UNITED STATES; a German Appraisal.—R. von Zwerger, in OEL UND KOHLE, vol. 13 (1937), No. 16, pp. 373-380.

The author gives an extended survey of geophysical explorations in the United States, with special reference to the Gulf Coast of Louisiana and Texas. While acknowledging that the Germans would do well to apply the highly developed American technic of reflection seismics to their problems, it is suggested that they still lead the Americans in the development of regional gravity surveys, and that the fuller development of practical geophysics which all desire is most likely to be found in a rational coordination of the gravity and reflection principles.

EFFECTS OF MOISTURE ON THE DIRECT CURRENT RESISTIVITIES OF OIL SANDS AND ROCKS—J. J. Jakosky and R. H. Hopper, in GEOPHYSICS, vol 2 (1937), No. 1, pp. 33-54.

The chief purpose of this work was to obtain information which would be of use in the interpretation of electrical well logs of uncased and cased drill holes; the general conclusions from that viewpoint are briefly:

1. Resistivity-moisture curves of both petroliferous and non-petroliferous rocks are asymptotic to the two axes and of a general hyperbolic form.

For the higher values of moisture content, the curves rapidly approach the conductivity of the electrolyte (moisture), while for very low values of moisture content the resistivity values are high and governed by the properties of the rocks.

2. Rocks containing soluble salts have critical resistivity values, with the change occurring in the neighborhood of 10 to 15 percent moisture content. Less moisture than this produces high resistivity values, while higher percentages of moisture produce somewhat lower resistivity values.

3. Rocks containing "fresh" waters are of relatively high resistance values which change fairly uniformly with change in moisture content.

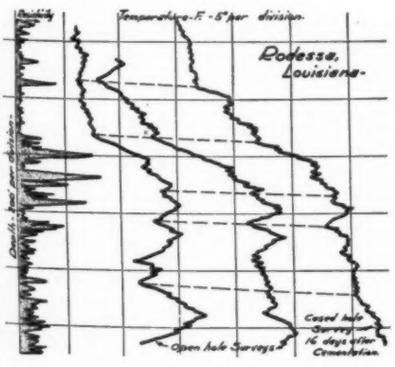
4. Presence of oil did not appreciably affect the electrical resistance of the rock. Resistance is governed almost wholly by the percent and nature of the electrolyte contained in the oil-bearing rock.

5. Interdependence of resistivity values on electrolytic effects shows that resistivity values alone will not be a reliable criterion for determining a rock type or predicting the presence of an oil sand. The subsurface electrolytic conditions in each oilfield must be evaluated before such direct interpretation is made. It will be recognized however that this limitation of direct current resistivity measurements does not preclude the use of the conventional depth-resistivity logs for correlations between wells. Knowing the lithology in one well it is possible to correlate other wells in the same area by similar electrical characteristics occurring on the electrical logs of the various wells. However, variations in absolute values of resistivity, caused by lateral or vertical changes in moisture, or soluble salt content in the strata, introduce complicating factors which must be considered before valid correlation or interpretation can be made.

DRILLING

Temperature Measurements for Cementation Control and Correlations in Drill Holes—Alexander Deussen and Hubert Guyod, in BULL. AM. ASSOC. PETROLEUM GEOLOGISTS, vol. 21 (1937), No. 6, pp. 789-805 (11 Figs.)

After comparing the early and the modern methods of temperature investigations in drill holes, the authors review briefly the main applications of these measurements to oil wells. Possibilities and limitations of two specific techniques are discussed, namely: location of cemented zones, and correlation between different wells. Location of the cement behind the casing by thermometric measurements is quite feasible and commercially successful, provided such measurements are made immediately after completion of the cementing job, and preferably before circulation of mud has taken place.



Although temperature measurements can not be expected to replace the electrical methods of logging wells, they may be used successfully in certain instances to correlate wells already cased where no other method of investigation can be applied. The accompanying diagram illustrates an example of correlation between three wells at Rodessa, Louisiana. One of them was cased and cemented, and the two others were open when the survey was made. The resistivity log plotted on the left shows that while some of the thermal anomalies correspond, in this particular example, to geological changes of formation, several of them are not shown on the electrical log. Distance between the most distant wells of this chart is 1½ miles.

Causes of Blow-outs.—Charles B. Carpenter, before A.P.I., DIV. OF PRODUCTION, Dallas, April, 1937.

Discussing the matter of blowouts, with special reference to the Gulf Coast region, a large share of the blame is laid on poorly conditioned muds; specifically, the two principal causes of blowouts while drilling are inadequate weight of fluid column and improper consistency of drilling fluids. Since both of these depend upon the condition of the mud, it behooves operators to watch this situation closely. Ability of drilling fluid to perform its desired action depends upon two properties: weight (specific gravity) and consistency.

Another cause of blowouts is the swab action incident to rapid withdrawal of drill pipe,which may be caused by an accumulation of cuttings around drill pipe and bit, or by high-viscosity, high-gel-strength mud. Danger of inducing swab action can be reduced by circulating drilling fluid for 30 minutes to one hour prior to withdrawing the drill pipe from the hole, an operation that always should be performed slowly.

Stability of clay dispersions in a drilling fluid is extremely important, since the fine particles or colloids are employed to suspend solid materials. Frequently this stability is disturbed by the precipitating action of electrolytes, and chemical treatment of drilling water is required.

Preventive measures include, in addition to mud control: mechanical equipment, such as pressure-tested casing, fittings, blowout preventers, and valves, as well as ample drilling fluid available at high pressure.

A trained personnel is a primary requisite for the prevention of blowouts while drilling, and the importance of coordination and team-work cannot be overstressed.

The danger of inducing swab action when withdrawing a formation test from the hole is greatly reduced by an equalizing by-pass on the formation test and slow withdrawal of the first few stands of drill pipe. Pressure drilling equipment, which to date has been used largely to control abnormal pressures, offers the safest means of preventing blow-outs during drilling.

Use of Wire-Line Core Barrels in California.—W. A. Clark in PETROL. ENG., vol. 8 (1937), No. 8, pp. 70-77.

Wire-line core barrels have been used since 1926. First results in California were unimpressive. Due to this and lack of equipment, slow development was predicted, but by the end of 1936, 130,000 ft. of hole had been cored.

Data on the use of the tool show its most economical use to be in wildcat wells, intermittent coring, and in deep wells. Use in shallow wells depends upon formations. It has not eliminated conventional coring, particularly in shallow wells; in wells drilled by operators who have not the proper equipment and in wells in which only a few cores are to be taken and which do not justify the extra equipment.

Advantages of Butane over Gasoline and Steam Engines in the Oil Fields.—L. R. Smith, in MINING AND METALLURGY, vol. 18 (1937), No. 5, pp. 248-249.

Butane-operated drilling rigs are a recent innovation in the petroleum industry, so extensive data on their operation are not available. However, experience indicates that, within limitations, as much can be accomplished with butane as with steam, at a decided reduction in expense of installation and cost of operation.

It was not until 1935 that any attempt was made to utilize it in California, as a source of power in oil-well drilling operations. At that time one of the major oil companies successfully equipped two single-engine rotary drilling outfits to operate on butane. This lead has been followed by others in the industry until now there are approximately 25 drilling units in California of varying horsepower and type of hookup, using butane.

At present there are three popular methods of utilizing the power of internal combustion engines in the operation of rotary outfits, each of which has been butane equipped.

(1) A single engine coupled directly to the draw works with a separate engine for the mud-pump drive.

(2) A dual engine installation wherein the pumping engine may be compounded with the draw-works engine for double hoisting capacity.

(3) A direct current, electric outfit with one or two engines acting as prime mover for generating the necessary direct current to handle the draw works, mud pumps, and other appurtenances connected with the rotary-drilling operation.

Referring to the single engine hookup, (1): A unit of this type operated by the Tide Water Associated Oil Co., including a 125-h.p., 1,800-r.p.m. engine, on the draw works with a 150-h.p., 900-r.p.m. engine on the mud pump, has made satisfactory progress on wells to 2,200 ft., setting 8⅝-in. casing at 1,950 ft. with 6⅝-in. liner to bottom. The rate of drilling has averaged 375 ft. per day to point of coring. The average cost per foot of completed well was $0.083 for engine operation and maintenance. The cost of drilling with the dual engine outfits (2) is somewhat higher, owing to larger hole size and greater drilling depth. Although not recommended for depths beyond 7,000 ft. they possess a facility of operation about that of steam. A 150 h.p unit drilling a 12¼-in. well at 3,500 ft. has shown an engine cost of $1.064 per foot of completed well.

As to (3), the direct-current electric outfit, as yet there are but two butane rigs of this design in operation in California. These have been in service with the Union Oil Co. since October, 1936. The operation of these two d.c. units over a period of six months indicates that the consumption of butane is somewhat higher than with the direct-connected outfits. However, on a footage basis and in consideration of hole size and drilling depths, the two classes of equipment are comparable. Maintenance on this class of equipment is low and apparently considerably less than for the direct-connected design. The principal advantages in this type of drilling unit lie in its extreme flexibility, high torque at low speed, and entire elimination of shock to the internal-combustion engines. An important point is that the equipment is arranged so that the stalling of the engines is impossible, hence considerable shut-down time is eliminated.

Preventing Rotary-Drilling Accidents.—R. B. Roaper, before AM. PETROL. INST., Colorado Springs, June, 1937.

The annual summary of the American Petroleum Institute of accident frequency and severity in drilling shows a frequency rate of the petroleum industry in 1936 to be 14.55, with a severity of 1.89. During the same year, in drilling operations throughout the country, accidents occurred with a frequency of 56.74 and with a severity of 7.59. From these figures we can see that drilling is almost four times as hazardous as any other type of work in the industry. It is obvious, therefore, that these statistics reveal an additional reason why the greatest expenditure of accident-prevention effort must be made in drilling operations.

Fundamentally, the prevention of accidents in drilling operations requires a technique no different from that employed in any other safety program; however, because of the rapid changes in drilling methods and equipment, it is necessary to keep the personnel trained to such a point that they can

constantly adjust themselves to such changing conditions. It is imperative also that all job planning, whether executive or supervisory, must include much more consideration of the safety feature of operations than has ever been given before.

For many years the customary attack on accident prevention was one of inspection and guarding of equipment. During the last four or five years, however, through the efforts of engineers, metallurgists, and other technicians, manufacturers of oil-field equipment have taken over, in a large measure, the responsibility of building safety into their products. Statistics show that less than 1 per cent of all accidents are a result of equipment failure. Our problem, therefore, has become one of preventing human failure.

The paper contains numerous pertinent suggestions.

CAUSE AND CURE OF FROZEN DRILL PIPE AND CASING.—J. I. Hayward, before AM. PETROL. INST., Colorado Springs, June, 1937.

One of the most serious accidents that can happen to a well is the sticking of casing, drill pipe, or tubing. Very little has been published regarding the cause and prevention of these accidents, and even less about overcoming them when they have occurred.

The author described laboratory apparatus and tests which show that stuck pipe can be freed by alternately starting and stopping the pumps; he then recites experiences where the same means were used successfully in the field and in the laboratory, tapping the pipe lightly while under tension was also found effective, and this method also was found to be substantiated in the field by water-hammer vibration, induced by pinching the pump suction. Comparative values of power required to free pipe are given for regular pipe with couplings, and flush-joint pipe. Field experiences are cited, including use of oil to free pipe, remedies used to overcome "key seating" (slotting of well bore), and other causes and cures for frozen pipe.

The paper contains a summary of replies to a questionnaire recently circulated by the Institute's Topical Committee on Drilling Practice soliciting information on concrete cases. General conclusions from replies to this questionnaire are as summarized above; the details make interesting and instructive reading.

OIL WELL OPERATION

WELL-SHOOTING WITH REFERENCE TO SECONDARY OIL RECOVERY.—Harry M. Ryder, in OIL & GAS JOUR., vol. 35 (1937), No. 51, pp. 62-66.

Various views are taken as to the physical effect of a shot on the oil sand of a well. The theory of the shot is that it enlarges the diameter of the well and thus provides more surface through which the oil may flow out. However, certain measurements made by the author after shooting a well indicate that the actual enlargement of the well diameter is compara ively small. The real effect undoubtedly lies in the fact that the sand is fractured in various directions, producing cracks which may together expose a very large extent of free surface. In this way a free surface may be created that would be equivalent to an actual well diameter of 40 to 50 ft.

Shooting of wells is practiced not only to increase the flow of oil from producing wells, but also to facilitate repressuring in fields where production under natural conditions has about ceased. For instance, an unshot well in a repressuring project may take 10 bbl. of water a day, but when the sand is fractured by a shot the intake may be nearly 3½ times as great. On this basis, when the input rate is 10 bbl. it might take 40 years to fill the sand to the economic limit; shooting may reduce this to 12½ years. However, there is another circumstance to consider. It is held by some that the oil in the immediate vicinity of the shot will be lost, but the evidence here is inconclusive. Possibly this difficulty if it exists, may be counterbalanced by adopting a wider spacing for shot wells in repressuring projects.

There is considerable evidence to show that the effectiveness of a shot in opening the sand is in direct proportion to the amount of nitroglycerine used. Sand tamping is being advocated as a means of adding to the effect of a given shot, or of decreasing the consumption of nitroglycerine.

PUMPING SLANT HOLES AT HUNTINGTON BEACH, CALIF.—D. K. Weaver, before AM. PETROL. INST., Colorado Springs, June, 1937.

At the Huntington field wells were drilled at angles as much as 62 deg. from the vertical in order to tap oil horizons beyond the ocean shore line; in one case a well 4,230 ft. deep was drifted horizontally 3,000 ft. Prediction has been made that such crooked wells could never be pumped successfully; however, the author shows that they can and are being pumped, and that the producing cost is not excessive.

The operations are not without difficulties, chief among which is sand trouble which becomes more aggravated as the fluid level is lowered. From a consideration of the prevailing circumstances the author predicts that the wells of this field can never be pumped to the "stripper stage" of from 10 to 15 bbl. although artificial repressuring or water flooding may be employed to obtain additional recovery.

PLUNGER TRAVEL OF OIL-WELL PUMPS.—Robert Wm. Rieniets, before AM. PETROL. INST., Colorado Springs, June, 1937.

An application of the theory of vibrations to the problems presented in calculating the plunger travel of a deep-well oil-well pump, in which some of the more pertinent factors controlling plunger travel and methods of evaluating them are described.

The general problem of calculating the plunger stroke of a rod-operated reciprocating-plunger type of pump involves the consideration of a number of different causes and effects created by conditions of restraint imposed upon the pumping system as a whole. The actual motion of the rods and plunger is rather complex, due to harmonies set up in the rod string—a condition which apparently does not materially affect the ultimate length of plunger travel, but does produce varying irregularities in the polished-rod loads as indicated by the surface dynagraph cards.

Plunger travel becomes one of the important factors involved in the successful operation of pumps, since, in part, it is one way of obtaining the desired pump displacement. Hence, it is directly related to pumping efficiency and production economy.

The length of stroke supplied to the polished-rod is probably the primary cause for the plunger stroke; but there are other causes secondary in nature which do contribute in varying degrees to the resulting stroke, and at times may assume as much importance as the polished-rod stroke, as has been shown from tests performed with the Gilbert-Sargent pump dynagraph.

It is felt that with an understanding of the manner in which these secondary factors affect the plunger travel and the relationship which they bear to existing operating and well conditions, it should be possible to use them to advantage in choosing a pumping installation and more accurately to predict from calculations what the plunger will do after the installation has been made.

From a method of calculation presented in the paper and results with a miniature pumping system the author states the following conclusions:

1. Increasing the area of the rods will result in greater plunger displacement for any normal speed of operation.

2. As pumping depths increase, the period ratio $\frac{T_1}{T_2}$ which is the relationship between pumping speeds (cycles per minute) and length of sucker rods, becomes increasingly important in controlling the plunger travel.

3. The loss of available plunger over-travel by virtue of the phase-angle relationship, and the high acceleration forces, both of which are associated with higher speeds of operation, indicate that lower pumping speeds and longer strokes should be resorted to in obtaining the desired pump displacement.

4. Damping may become an important factor in limiting the operating speed when the period ratio $\frac{T_1}{T_2}$ approaches or becomes greater than 0.5. In the event of very heavy damping, it may become advisable to secure the desired displacement by the use of longer and slower strokes.

VIBRATION PROBLEMS IN OIL WELLS.—J. C. Slonneger, before AM. PETROL. INST., Colorado Springs, June, 1937.

The author discusses a simplified method of calculating vibration frequencies as applied to sucker rods and cable tools, and shows ready reference charts for these frequencies.

In the discussion of the effects of vibration on oil-well pumping, it is disclosed that the vibration of the rods has a profound effect upon the contour of the dynamometer card. This is shown by the development of a series of theoretical cards from the standpoint of vibration and well loads which have characteristic contours, easily recognized in the actual dynamometer card. Numerous dynamometer cards, taken from operating wells and covering a variety of well conditions, are shown which confirm the theoretical consideration.

Cable tooling is also briefly discussed. There are, however, no hard and fast conclusions.

FLOW OF MIXTURES OF OIL AND WATER THROUGH SAND.—F. B. Plumme, J. C. Hunter and E. H. Timmerman, before A.P.I., DIV. OF PRODUCTION, Dallas, April, 1937.

In the partially depleted oil fields of the United States more than twice as much water as oil is produced, involving a serious economic handicap because of increased pumping costs, handling of emulsified oil, and losses due to unrecoverable oil trapped by water in a sand.

According to certain theories, a sand bearing both water and oil should, under otherwise constant conditions, produce water and oil in proportion to the viscosities of the two fluids, but it does not always work out that way. Due to interfacial tensions between water and oil, and factors referred to as capillary phenomena, a much larger proportion of water than oil is obtained from fine-sand reservoirs. It is also well known that in reservoirs having relatively coarse-grained sand and rapid rates of flow, the water "cones" around the well, and an abnormal percentage of water is produced. If the well in the coarse-grained sand is "pinched in" and allowed to produce very slowly, the "cone" is said to be depressed and the proportion of oil to water is generally increased. On the other hand, if a well producing from very fine-grained sand is "pinched in," an increase in the percentage of water production often results.

The problem here presented is to find means to neutralize the adhesion tensions and other phenomena that result in "coning." The question was studied experimentally with the aid of a grant by the Shell Petroleum Corp. and investigation proceeded along the line of chemical treatment. Chemicals found most satisfactory are those that reduce the surface tension of water and do not mix with oil—namely, the various kinds of soaps such as laurates, stearates and oleates of sodium and potassium. When this idea was applied to cores of fine grained sand and a mixture of kerosene and water the flow of water with the kerosene was reduced from 75 percent to 5 percent. Better results were obtained with fresh than with salt water, because most soaps are insoluble in brines such as occur in many oil wells. (The new sulphonated oil soap might help here. Ed.) It may be that with further study the author's idea will become of distinct use in the oil industry.

NATURAL GAS

Gas Hydrates in Natural Gas Pipelines—Wm. Deaton and E. M. Frost, before Am. Gas Assoc., Nat. Gas Dept., Kansas City, May, 1937.

Freezing of natural gas pipelines is not confined to areas of extremely low winter temperatures, but is experienced everywhere that gas is transported under high pressure. The reason for the common occurrence of pipeline freezing is that natural gas under pressure will combine with water to form solid compounds that resemble ordinary ice but remain solid at temperatures much higher than the normal ice point of 32 deg. F.; in general, the higher the pressure the higher the temperature at which hydrates will form. To determine possibility of hydrate formation in a pipeline, it is necessary to know both the temperature and pressure of the gas; one is as important as the other. The pressure is easily determined and is usually available from the records of operation but the temperature of the gas in the pipeline is seldom known. It has been observed that usually little information about the temperature prevailing in pipeline is available. To supply this information, a temperature survey of the Amarillo-Denver pipeline was undertaken. This line is 340 miles long and 22 to 20 ins. in diameter. The pressure is 300-350 lb. and as it leaves the absorption plant the gas is saturated with water at 75 deg. to 90 deg. F. The gas transported amounts to 25-85,000,000 cu. ft. a day. Thermometers were inserted in the line at suitable intervals and temperature measurements were made throughout the year.

The general result is to show that the temperature of the gas at any given location is relatively uniform; it changes slowly with the season but is little affected by temporary weather changes, unless affected by disturbing influences the temperature of the gas a short distance from the compressor station is the same as the ground temperature at the center of the pipeline.

Laboratory work confirmed the fact that it is difficult to get gas hydrate crystals to form even at high pressures, but once formed the process continues at pressures only a little higher than those at which the hydrates decompose. The pressures and temperatures of crystal formation depend to a large extent on the composition of the gas itself, hence it is of some importance to study the character of the gas being transported.

There are numerous methods in use for unblocking a pipeline that has become clogged by gas hydrate crystals. One is to reduce the pressure in the section of line that contains the freeze-up. The authors consider this method the most promising where its use is practicable and the temperature is above 32 deg. F. Most thorough protection is afforded by completely dehydrating the gas at the initial compressor stations.

Increasing Flow of Small Producing Gas Wells—S. W. Meals, before Am. Gas Assoc., Nat. Gas Dept., Kansas City, May, 1937.

Maintenance of production from small gas producers is of much importance in the Appalachian field. In Pennsylvania and West Virginia there are more than 32,000 shallow-sand wells with an average daily production of approximately 30,000 cu. ft. per well. Present market conditions are such that it is profitable to drill in territory where the most that can be expected is about 200,000 cu. ft. a day, and efforts are even made to save wells that will feed only 10,000 cu. ft. into the line.

The saving of these feeble wells is a matter of preventing mud and water from penetrating the producing formation, and after the well has been drilled to keep the face of the formation clean. Various devices are available for the purpose—cementing off water sands, "shooting," acidizing, etc. The pores of an initially clean producing surface eventually become clogged from one cause or another, so periodical reopening of the pores becomes necessary. One device is to create heat by dumping in a mixture of strong sulphuric acid and strong caustic soda solution. The latest of these devices, and the one that has given the largest increase at the lowest cost, is the use of caustic soda and aluminum slugs or pellets. One hundred pounds of flaked caustic soda and 5 lb. of 5 percent aluminum shavings, pellets or small slugs with 1 to 1½ bbl. of water (salt water is much better than fresh) poured into the well will create a temperature of 250 deg. F. and the action of the caustic soda on the aluminum has a scrubbing effect. This should be left in the well overnight and then the well bailed out and the sand formation washed. The caustic soda can be dissolved in the water and dumped in the well by means of the bailer, or simply poured in, and the aluminum slugs dropped in.

Old wells are helped by giving them a rest at times; shutting in to build up the rock pressure enables the well to clean the sand pores.

Injecting or storing gas in the sand seems to open up clogged sand pores and has been beneficial in increasing the gas output.

The life of a well and the ability to produce largely depends upon the conditions of the reservoir from which the well is producing. Some wells have been producing for more than 30 years.

Some shallow sands are long lived. A gas well that was drilled in 1860 is still producing sufficient gas to operate the oil lease and supply several dwelling houses on the lease, thus testifying to what may be expected from some shallow sands where proper care and attention is given to keeping sand face free from foreign matter.

PETROLEUM REFINING

The Production of Gasoline and Lubricants by Catalytic Hydrogenation Under Pressure—Giacomo Fauser, in Riv. Ital. Petrolio, vol. 5 (1937), No. 50, pp. 1-10.

The process of hydrogenating Albanian crude oil from the Devoli field, soon to be initiated in two plants now under construction at Bari and Livorno, is outlined as follows:

The crude oil first passes a stripping column to separate gasoline, middle oil and heavy residue. The latter, together with a suitable proportion of hydrogen, passes through heat exchangers and superheaters into a reaction column containing a catalyst. The reaction products from this liquid-phase hydrogenation pass into a hot separator where the heavy products are deposited; the excess of hydrogen and the gasoline and light oils in vapor form pass through heat exchangers and a condenser into a cold separator where the light oils and gasoline are separated. Excess hydrogen is separated from the gaseous hydrocarbons in an oil absorber and is returned to the cycle. The gasoline-light oil mixture is fractionated; the gasoline goes to storage and the middle oil is subjected to another hydrogenation this time in the vapor-phase, using an appropriate catalyst. Middle oil not converted into gasoline is returned to the cycle; the gasoline obtained requires only a simple caustic wash. The hydrogen necessary for hydrogenation is obtained from the permanent hydrocarbon gases formed during the process as a result of "parasitic" reactions. These gases are first purified from hydrogen sulphide, from which pure sulphur will be obtained at the rate of 6,000 tons a year; then the residual gas, consisting mostly of methane, is decomposed at 800 deg. C. by water vapor into CO and H_2; in a second step at 500 deg. the CO is converted by additional water vapor into CO_2, which is removed by a water-wash under 28 atmospheres pressure; the last traces of CO are absorbed in a cupro-ammonium solution.

Lubricating oil is obtained from the heavy fraction from the primary distillation at 320 deg. C. This residue is first subjected to vacuum distillation to eliminate asphalt. The distillate, corresponding to 27 percent of the original crude, has a very low viscosity index—about 30 which is raised to 70 by a liquid-phase hydrogenation with a suitable catalyst under definite conditions of temperature, pressure and time. In the same reaction there are obtained excellent light oils with high cetene numbers, suitable for Diesel engines. Facilities are also being installed at these two plants for cracking heavy residues from other sources. The two plants as at present designed will handle 240,000 tons of crude Albanian oil a year; at that rate the reserves of the Devoli field will last 50 years.

The general result of this process is that Devoli crude oil, which has an asphalt base and a high sulphur content and which by ordinary distillation and cracking would yield at most 40 percent of gasoline, is made to give a yield of 80 percent of high grade gasoline with an insignificant sulphur content.

The author observes that the cost of synthetic gasoline is higher than that of the natural product. However, he goes on to say, in underwriting these two establishments the Italian government is acquiring something besides gasoline and lubricating oil, it is making a wise investment in the national security that lies in the possession of those indispensable necessities of peace and war; short-sighted economists may argue that Devoli gasoline costs too much, but in a broad view of all the circumstances it has a value not adequately measurable in commercial terms.

Experimental Solvent-Extraction Tower Unit.—Herschel G. Smith, before Am. Petrol. Inst., Colorado Springs, June, 1937.

A 15-foot glass, continuous-extraction tower unit for experimental work and control purposes has been evolved that gives very satisfactory results for both experimental and plant-control purposes. The unit is provided with control features for meeting all desired variables in the way of volume, temperatures, and other operating details. A still larger unit, constructed of steel, of the same similar general arrangement has also proved satisfactory for operation at higher pressures.

High-Octane-Number Blending Stocks Produced by Solvent Extraction—E. Saegebarth, A. J. Broggini, and E. Steffen, before A.M. Petrol. Inst., Colorado Springs, June, 1937.

Straight-run naphthas from widely-different types of crudes are extracted with liquid sulfur dioxide at temperatures of from 0 to —60 deg. F. Regardless of the origin of the charging stock, excellent separation of the high-octane-number constituents, comprising the unsaturated and aromatic hydrocarbons, from the low-octane-number constituents, comprising the naphthenic and paraffinic hydrocarbons, is obtained. The aromatic and unsaturated hydrocarbons are dissolved by liquid sulfur dioxide. After recovery of the solvent from the extract solution, blending stocks are obtained with octane numbers ranging from 80 to 90, depending upon the extraction temperature. Upon further fractionation, stocks with octane numbers as high as 100 may be produced.

These blending stocks are suitable for raising the octane number of motor fuels. The freedom from gum and the stable charactersitics of these stocks especially favor their use in aviation fuels. They are also widely used as solvents for lacquers and varnishes due to their high Kauri butanol numbers. A semi-commercial plant which was used in these experiments is described. A 6,000-bbl. commercial plant operating at low temperature, has been in operation for about eight months. Evaporating liquid ethane is used in this plant for cooling the distillate and solvent to the extraction temperature, rather than a brine system as described for the pilot unit. Liquid propane is used to condense the ethane. This two-cycle refrigeration system has proved to be very efficient for producing low temperatures.

Solvent is recovered in this unit by means of a multiple-effect evaporation system, as is normally done in Edeleanu plants, with the exception that fractionating columns are used to hold back light-oil vapors. The vacuum stage is by-passed during naphtha operation.

Data are reported from operations on naphthas from a Mid-continent, a Sumatra and a South Texas crude. The yields of high-octane number (80 to 91.1) stocks varied from 9.1 up to 46.5 volume

percent. Treating costs per barrel of charge amounted to 5.57 cents when operating at —60 deg. F. and 4.61 cents at 0 deg. F.; the lower the extracting temperature the higher the octane number. At temperatures in the neighborhood of 14 deg. F. appreciable quantities of naphthenes and paraffins are dissolved, thereby reducing the octane number of the blending stocks.

Effect of Sweetening on the Properties of Gasolines.—W. A. Schulze and A. E. Buell, before AM. PETROL. INST., Colorado Springs, June, 1937.

Experimental data are presented to show that naphtha solutions of mercaptans and the corresponding disulfides have the same octane number within range of concentrations encountered in commercial gasolines. These compounds act similarly in naphthas containing tetraethyl lead equivalent to 1 cc. per gallon.

Losses from one-half to three octane numbers are shown on gasolines sweetened in plants employing various modifications of the doctor-sweetening process, the losses being explained on the basis of the higher alkyl polysulfides formed during the oxidation of the mercaptans in the gasolines.

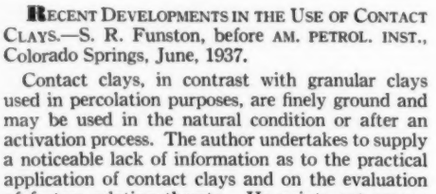
Experimental data confirm the statement that the deleterious alkyl polysulfides are not formed in sweetening by the copper process. Direct comparison of sour and copper sweetened gasolines shows that for all practical purposes the octane number is unchanged during the sweetening treatment.

The higher alkyl polysulfides formed in doctor sweetening are very unstable compounds, and make gasolines less color stable to sunlight and potentially corrosive. Synthetic and natural gum inhibitors likewise are rendered less effective. Copper-sweetened gasolines, therefore, are considerably superior to gasolines sweetened by conventional methods.

Recent Developments in the Use of Contact Clays.—S. R. Funston, before AM. PETROL. INST., Colorado Springs, June, 1937.

Contact clays, in contrast with granular clays used in percolation purposes, are finely ground and may be used in the natural condition or after an activation process. The author undertakes to supply a noticeable lack of information as to the practical application of contact clays and on the evaluation of factors relating thereto. He points out among other things that recent studies have demonstrated that the presence of a certain amount of free moisture (as much as 15 percent) in a contact clay is of advantage when contacting above 210 deg. F.

He further points out that methods of testing contact clays are at considerable variance throughout the industry. As a contribution to remedying this condition he outlines test methods for determining the decolorizing efficiencies of contact clays, oil retention, and press rate of contacting, and winds up with an outline of recent developments in plant technique. The relation of laboratory results to decolorization in plant operations is emphasized, as in the accompanying diagram.



It will be noted here that test points both for laboratory and plant lie in a straight line in fair conformance to the adsorption isotherm. Furthermore, the plant and laboratory lines are substantially parallel. By ascertaining the relative clay consumption at 1¼ Tag-Robinson as indicated by these lines, it will be observed that plant "A" is operating at but 56-percent potential efficiency. In terms of clay values alone, this represents a handicap approximating 35 cents a barrel against the potential. While it may not always be possible from a practical standpoint to duplicate "potential" operating efficiency, the laboratory control test can be accepted as a satisfactory guide.

Refinements in Sweetening Technique.—J. A. Altshuler and F. G. Graves, before AM. PETROL. INST., Colorado Springs, June, 1937.

The sweetening of sour gasolines, both cracked and straight-run, has been a troublesome burden to the petroleum industry for many years. In many refineries this branch of processing has been permitted to follow the path of least resistance. As a result, it generally has been the practice to manufacture a "doctor-sweet" product as demanded by the consumer by some method, regardless of what it might have been, with practically no serious attention paid to losses accompanying such treatment. This utter disregard in the past for sweetening losses and resultant high costs have usually been considered as something which "had to be" in order to prepare a satisfactory marketable product.

It is the purpose of this paper to point out where the major losses may be found, what their cost is to the industry, and to indicate what steps may be taken to correct them.

The largest saving in chemical costs was effected in doctor sweetening when regeneration of the spent chemicals was adopted. Where this process is efficiently practiced, further potential savings in this item alone are insufficient to justify additional expensive research work or plant modification. The main losses in present doctor-treating operations are those of gasoline and knock rating, with resulting increase in cost to maintain knock rating specifications. The unavoidable addition of excess free sulfur, with its attendant detrimental effect on specifications and inhibitor susceptibility, result in further unnecessary processing cost. These factors fully justify improvements in the sweetening operation.

The Stratco lead-sulfide process sweetens by catalytic oxidation, using air for the oxidizing agent. The catalyst is a suspension of lead sulfide in strong caustic-soda solution. Since the process is catalytic, the chemical consumption is minimized—being due solely to mechanical losses and that small quantity required to maintain the catalyst at its maximum effectiveness. Operating continuously in a closed system without "blackstrap" emulsions, gasoline losses are negligible. Previous over-treatment and production of poor copper-strip-test stock, necessitating retreatment are eliminated because no free sulfur is used. Knock-rating losses and tetraethyl-lead requirements have been reduced to a minimum. Thus the lead-sulfide process permits the fullest realization of possible economies in sweetening.

Solvent Refining of Lubricating Oils from the Point of View of the Operator.—V. A. Kalichevsky, T. P. Simpson and B. W. Story, before AM. PETROL. INST., Colorado Springs, June, 1937.

The point of view considered by the authors is the natural one of the largest yield of the best product at the least cost. The elements to be considered are the charging stock, the solvent, and efficiency of the equipment. The charging stock is of most importance.

Solvent refining operations are not as simple as they may appear, due to numerous varying circumstances. There must be a certain differential between the boiling points of stock and solvent; low-boiling solvents may be used for treating light oils, and higher boiling solvents for heavier oils. Certain oils require solvent treatment with refrigeration, whereas refrigeration may be avoided by a proper choice of solvent. Again, solvent power is not the same with all solvents on all stocks at the same temperatures, which presents another occasion for discriminating choice of solvents and temperatures as regards particular kinds of stocks.

While solvents permit the refiner far more latitude in the degree of refinement to which a stock may be treated than was generally possible with acid, there are limits beyond which it is not economical or even desirable to go. A higher viscosity index may usually be obtained with solvents than with acid from a given stock, but a point is reached where the viscosity index increases very slowly while the yield decreases rapidly, and that is obviously the economic refining limit for the particular stock in question. It is not always advisable to refine a stock to the economic viscosity-index limit, because a distinct loss in oxidation resistance may develop before that point is reached. Therefore, the maximum viscosity index which a stock is capable of producing economically may not be the best point to carry the refining in practice.

Beyond the weighing of such considerations is the matter of equipment. It so happens that most of the compounds that come into consideration as solvents are heavier than oil and this makes the packed tower a suitable means for effecting solvent extraction. In the operation of such towers there are two prime factors: height of the tower by which time and surface of contact are most advantageously exploited; and temperature gradient through the extraction system, in the sense that the temperature is gradually increased toward the extract end. Another important manipulative means in the case of mixed solvents is a change in the ratios of the solvents as the extract end is approached. In all these matters it is the nature of the charging stock that controls.

The authors add that it is clearly impossible to make a fair direct comparison of the various commercial processes now in use because of the widely-different nature of the charging stocks they are handling. No one process is best for every stock, and, therefore, no single stock can be used for such a comparison except by the refiner who is interested in that particular stock to the exclusion of all others. Neither is it fair to discuss the mechanical equipment in vogue at the moment with any particular process. Solvent processes are comparatively young, and practically all have been changed more or less since their introduction. It seems unquestionable that other changes will be made, and that some may even be under way. We might dwell on details of the chlorex or furfural processes, for instance, only to find that tomorrow they are no longer simply chlorex and furfural but have had something added to them, as happened with the Edeleanu process.

ASPHALT AND TAR

The Constituents of Asphaltic Materials versus Accelerated Weathering.—R. R. Thurston; before AM. SOC. TESTING MATERIALS, New York, June-July, 1937.

Approximately 200 deg. F. melting point asphalts prepared from Mexican, Gulf Coast, and Mid-Continent crude and a cracked residue have been separated into asphaltenes, resins and oils. Synthetic asphalts have been prepared by recombining these constituent in various proportions and from different sources. Accelerated weathering data were obtained on these materials. Results indicated an increased resistance to weathering when increased proportions of resins were used.

Development of Internal Structure in Asphalts with Time.—R. N. Traxler and C. E. Coombs, before AM. SOC. TESTING MATERIALS, New York, June-July, 1937.

The increase in consistency of asphalts with time (age hardening) indicates the development of

internal structure. This structure is developed more rapidly in air-blown than in steam- or vacuum-refined bitumens. It is wholly or partially eliminated by heating or mechanical working. The higher the rate at which internal structure develops, the more marked is the deviation from viscous flow. Asphalts with high rates of age-hardening and definite deviations from viscous flow give characteristic microscopic patterns when the surfaces are etched with ethyl ether or 86° Beaumé naphtha.

USES OF PETROLEUM

Fundamentals of Extreme Pressure Lubricants—Willi F. Pauk, in MOTORENBETRIEB U. MASCHINEN-SCHMIERUNG, vol. 10 (1937), pp. 2-5; PETROLEUM, vol. 33, No. 23.

Under normal conditions of temperature and speed of revolution the pressure in a bearing must not exceed 100 kg. per sq. cm. (1,420 lb. per sq. in.) if there is to be maintained a film of lubricating oil between shaft and bushing. When this condition is exceeded, as in the use of hypoid gears in recent types of automotive gears, satisfactory lubrication (i.e., maintenace of an oil film in the bearing) cannot be provided by ordinary lubricating oil, so a new type of lubricant—the so-called extreme pressure (E. P.) oils have had to be invented.

At the present time the E. P. lubricants comprise three groups, as follows:

1. E. P. lubricants consisting of a mineral oil mixed with a fatty oil in which a sulphur-chlorine compound has been chemically dissolved.

2. E. P. lubricants consisting of a mixture of a mineral oil and a fatty oil in which elemental sulphur has been chemically dissolved.

3. E. P. lubricants consisting of a mixture of mineral oil and a lead soap.

According to present experience and machine tests the first named type in general shows the greatest resistance to extreme pressures. However, the presence of chlorine in these lubricants constitutes a latent danger of corrosion, especially if water obtains access to the bearing.

The second type affords a five-fold resistance to extreme pressure and is generally safe and satisfactory; there appears to be no danger of corrosion through contact with water.

Under ideal conditions the third type gives a 15-fold resistance to extreme pressure, especially if a certain amount of sulphur is included in the mixture. However, in this latter case there is danger of a separation of lead sulphide during operation, unless the lubricant has been manufactured with great care, and such separation is extremely undesirable. Nevertheless, this type, under the name Hypoid Compound, has been prescribed for some American automobiles.

The requirements to be put on E. P. lubricants are therefore: maintenace of a lubricating film under high pressure; freedom from corrosion phenomena and from separation of constituents during use; minimal friction values, expressed in a low friction coefficient; a flat viscosity curve, which means a high viscosity index.

The use of E. P. lubricants is not necessarily limited to automobiles but may be extended to special cases in various industries, as high-ratio transmission gears productive of abnormal loads (high speed centrifugals); also as wire drawer's grease, cutting oil, gear grease, wire cable grease. etc.

Lubrication of Journal Bearings in Oxidizing Conditions—C. Jakeman and A. Fogg, in JOUR. INST. PETROL. TECHNOLOGISTS, vol. 23 (1937), No. 163, pp. 350-366.

A previous investigation appeared to show that prolonged running of a journal bearing when the lubricant was subjected to blowing with hot air caused a fall in the minimum coefficient of friction and a rise in the seizing temperature. Observations were in agreement with the general behavior of oils and the improvement noted was attributed to a change in the lubricants.

The new series of tests was undertaken in conjunction with the Air Ministry Laboratory, in order to ascertain whether there was any explanation, other than oxidation of the oil, of the experimental results.

Experiments were made on N.P.L. journal friction machines with nickel chrome steel journals and bronze bushes. Lubricants were commercial varieties of mineral oils, all except one being types used for internal-combustion engine lubrication. Oxidizing conditions during running were obtained by means of hot air at 160 deg. C. blown into the oil during circulation in the machine; a wash-leather filter was used in the oil-circulating system. In all cases the conditions of the tests were as follows: Load: 1,000 lb. sq. in.; speed: 1,300 r.p.m.; diametral clearance between bush and journal: 0.008 in.

Starting with a new bushing and running to seizure about every six or seven hours, the seizing temperature of one of the oils increased from about 200 deg. C. to about 300 deg. C., and the minimum coefficient of friction decreased from 0.0008 to 0.0005_5 in a period of about 30 hours. A sample of the same oil subjected to oxidizing conditions before running in the machine, gave similar results. When a sample of the new oil was run in one of the bushings which had already been used, the same values, seizing temperature 300 deg. C. and minimum coefficient of friction 0.0005_5 were reached, after one or two seizures. Each of several other lubricants tested in a bushing already "run-in" gave its optimum performance on the first run, and further blowing did not affect the results.

The improvement in seizing temperature and minimum friction was also obtained when fresh oil was fed to the bearing continuously, any possibility of cumulative oxidation being eliminated.

In the case of the oils examined, little, if any, of the improved performance is due to change in the lubricant, but to changes in the form of the bushing and in the quality of the running surface.

In a supplementary experiment occasion was taken to test the effect of doping pure castor oil with ethyl fluid. These tests showed that ethyl fluid tended to deteriorate the bearing surface and to lower the seizing temperature.

PETROLEUM SUBSTITUTES

Gasoline from Trees—Anon. in PETROLEUM, vol. 33 (1937), No. 23, p. 14.

The writer quotes from a report by an Italian Commission that has been investigating possibilities of obtaining supplies of motor fuel in Ethiopia. As sources of alcohol the Commission lists corn (maize), various kinds of sorghum, and ivory nut trees which grow in great profusion and from which mannose, a fermentable sugar, can be obtained; alcohol from these sources would cost less than to produce it in Italy.

An entirely new source of motor fuel is found in the Candelabra tree (an Euphorbia) which is said to cover a great area in dense stands. This tree produces a milky latex which is said to contain up to 60 percent of its weight of a hydrocarbon very similar to benzene. This latex is easily obtained by tapping the trees in much the same manner as rubber trees; the separation of the hydrocarbon is very simple. The annual yield per tree is said to be 7 to 10 lbs. The Commission concludes that so long as the occurrence of appreciable amounts of petroleum in Ethiopia is not proven efforts should be made to exploit these agricultural products.

Carbon Monoxide in Engine Exhaust Using Alcohol Blends.—L. C. Lichty and C. W. Phelps, in IND. ENG. CHEM., vol. 29 (1937), No. 5, pp. 495-502.

One of the supposed advantages of alcohol-gasoline motor fuel is that output of carbon monoxide from internal combustion engines in which the blend is used as fuel would be materially reduced, thus mitigating a hazard to health and life, but it seems that this exception is not likely to be realized.

Tests on engines with gasoline and 10 and 20 per cent ethyl alcohol-gasoline blends show that the amount of carbon monoxide in the exhaust gases depends upon the air-fuel ratio and is practically the same for all three fuels at air-fuel ratios comparable with regard to theoretical air requirement for the particular fuel.

With all fuels, air-fuel ratios necessary for desirable engine performance result in carbon monoxide in the engine exhaust and in the blow-by gases which leak past the engine piston. Variations in carbon monoxide from individual exhaust ports, indicate, for the fuels studied, that factors other than fuel characteristics are the more important in influencing distribution of air or fuel, or both, in the engine used.

Carbon monoxide can be eliminated either with gasoline or alcohol-gasoline blends by providing more air than is required for complete combustion but this condition results in a lowered performance that is not considered desirable.

RESERVES

Crude Oil Reserves of Western Kansas.—Marvin Lee, in OIL WEEKLY, vol. 85 (1937), No. 8, pp. 48-49.

This estimate of known reserves in western Kansas is restricted to the part of the State west of the principal meridian. It gives no consideration to the older fields, east of this meridian. Neither does it include oil recovered from fields of the western area prior to January, 1937. It is an effort to determine the amount of oil still to be recove ed by known producing methods, from the fields now existing.

The author's computation as of the above mentioned date shows the following:

From Lime Formations	226,000,000 bbl.
From Sand Formations	31,000,000 bbl.
From the Conglomerate	16,000,000 bbl.
Total Reserves	273,000,000 bbl,

Limes of Western Kansas and of Pennsylvania. Mississippi and Ordivician ages. In this classification is the formation known to the area as "chat," which is found in the upper portion of the Mississippi lime. The conglomerate is a basal portion of the Pennsylvania rocks and on account of unconformities is not found at any uniform stratigraphic position. In some instances it is a sand, possibly the same as the Reagan sand in Oklahoma and the Lamotte sand in Missouri.

There are now 155 oilfields in this area, many of which are in an incomplete state of development, and developments in 1937 are expected to add another 50,000,000 bbl. to the reserves. Rate of development this year promises to exceed that of 1936, which was a record.

Estimate of Natural-Gas Reserves for Horizons in the Oklahoma City Oil Field.—R. E. Heithecker in BUREAU OF MINES REPORT OF INVESTIGATIONS No. 3338, April, 1937.

In connection with a survey of gas reserves in the Layton, Oolitic and Oswego-Prae zones in the Oklahoma City field the author discusses the basis of such surveys.

It has been shown that to calculate or estimate the gas reserves during the early life of a gas field the porosity area method is the only available method. The more information the engineer has at hand regarding the areal extent of the field, the effective porosity, thickness and temperature of the producing formation, location of the gas-oil or gas-water contacts, and deviation of the gas from Boyle's law, the more accurate the estimate can be made.

Later in the life of the field, however, after sufficient quantity of gas has been withdrawn from the reservoir to cause an appreciable drop in formation pressure, the estimates of reserves may be calculated by the "pressure-volume" method. The required data are total amount of withdrawals from the

reservoir in intervals of one, three, or six months, depending upon the age of the field; shut-in wellhead pressures at intervals during the producing life of the wells and information regarding the temperature of the reservoir; water encroachment; and the deviation of the gas from Boyle's law.

The estimates of the quantity of gas reserves in a reservoir should be considered "estimates" because it is obviously impossible to calculate exactly the quantity of gas in a horizon. When any one of the many factors considered in setting up the estimate is in error, the final figure of gas reserves will be inaccurate in proportion to the influence this factor has upon the final answer. However, the older the field (provided reasonably accurate data are available as to all the factors considered in making the estimate) the more accurate the final estimate will be, regardless of the method used.

Based upon calculations in this report, there was an initial gas reserve in these three zones of 267,599,730,000 cu. ft. It is estimated that 214,566,912,000 cu. ft. had been withdrawn from these formations up to January 1, 1936, leaving a gas reserve of 53,032,118,000 cu. ft. based upon an abandonment pressure of 100 lb. per sq. in. gauge at the wellhead.

PETROLEUM ECONOMICS

Economics of the Oil Cooperative and Its Future—Thomas J. Quinn, in NAT. PETROL. NEWS, vol. 29 (1937), No. 23, pp. 39-43.

This analysis indicates that no startling developments may be anticipated in the field of consumer co-operation in the immediate future unless radical changes occur in economic conditions. One of the chief factors contributing to formation of co-operatives is a wide spread between income and outgo for any particular consuming group. This is reflected in the spread between prices for farm supplies and prices for farm products. It is also reflected in the lag between commodity prices and workers' wages. Another contributing factor is wide margins.

Any modification in the economic system tending to create these conditions might provide an impetus for spread of co-operative movement. This would be true of inflation, for example. Under inflation, prices tend to rise much more rapidly than wages, and prices of certain commodities rise more rapidly than others. Under such conditions, wage earners and farmers would undoubtedly be prompted to form co-operatives in an attempt to bring expenditures for commodities more into line with income.

Any marked increase in demand for a product which would encourage granting of wide margins to distributors would also encourage formation of co-operatives. Current trends in the petroleum industry point toward narrower margins, so there appears to be only a remote possibility of this factors aiding the co-operative in this industry. In this connection, the point must, however, be emphasized that the Robinson-Patman Act and resale price maintenance legislation which tend to "freeze" existing margins may encourage formation of co-operatives.

From this brief analysis it is reasonably clear that the efficient distributor in the petroluem industry as well as in other retail fields has little to fear from competition of co-operatives unless unforseen circumstances intervene.

Proration of Allowable Oil Production.—Lyndon L. Foley, before AM. PETROL. INST., Colorado Springs, June, 1937.

Granting the desirability of curtailing production to meet market demand, and granting that the states have the power to do so, there is still a wide range of opinion as to what constitutes equity in proration. Many people have held the opinion that proration should give each operator an allowable production proportional to his probable recovery under unrestricted production. This consideration led to the use of well potentials as the basis of proration. Restriction of production limits the individual's right to capture oil, and has led gradually to a recognition of the ownership of oil in place in the reservoir. The preponderance of opinion at present favors an allocation of allowed production which will give each operator an allowable production proportional to the recoverable oil under his land. This principle was recognized by the courts in the case of Brown v. Humble Oil and Refining Company, in which the court held that the recoverable oil under a given lease in a developed field could be determined approximately by experts who can also determine equitably the amount of oil and gas recoverable by the owner of each tract under certain operating conditions.

Various proration plans may be rated as to fairness as follows—the standard of equity being an allocation proportional to the recoverable oil under each lease:

Per-well allowances—equitable only if well-spacing and reservoir conditions are uniform.

Straight potential—equitable only if well spacing is uniform, and if well potentials are proportional to recoverable oil in place in the drainage area of each well.

Per-acre allowances—equitable only if reservoir conditions are uniform.

Acreage allowance plus any other allowance—will not give allocations proportional to the recoverable oil under a lease.

Acreage times potential—equitable only if potentials are proportional to the recoverable oil under a lease. This plan gives each lease a per-acre recovery proportional to the well potentials.

Acreage times index of recoverable oil—equitable if the index of recoverable oil is accurate. This plan gives each lease a per-acre recovery proportional to the index of recoverable oil, and is reasonable in the light of our knowledge of indices of recoverable oil at any given time it may be applied.

The application of a reservoir-pressure factor to any of the above proration plans may correct wholly or partly any inherent inequity of the plan.

It must be emphasized most strongly that any factor which is considered indicative of the recoverable oil under a lease or proration unit must be multiplied by the acreage of the tract to determine the proration factor. It is only in this way that a daily allowable production may be assigned which will give each tract an ultimate per-acre recovery proportional to the "index of recoverable oil" of the tract.

Oil Consumption in Brazil.—Oskar Tokayer, in PETROLEUM PRESS SERVICE, vol. 4 (1937), No. 22, pp. 257-259.

As in the case of other countries, demand for petroleum products during recent years clearly reflects the general economic trend in Brazil:—

Mineral Oil Consumption of Brazil (in 1,000 Metric Tons)

	Gasoline	Kerosene	Lubricants	Diesel Oil*	Fuel Oil*	Total
1929	282	101	37	49	301	770
1931	219	32	25	52	294	672
1933	218	79	28	66	350	741
1934	259	96	31	65	396	847
1935	285	84	34	70	437	910
1936	323	102	30	75	500	1,030

*Including Bunker Fuel.

In view of the difficulties confronting development of long-distance motor transport in a country with the physical characteristics of Brazil, gasoline consumption is confined mostly to large seaport towns but within its comparatively restricted limits, demand has shown a strong recovery in the last three years and in 1936 exceeded the 1929 peak by some 15 percent. To some extent the development of gasoline sales has been hindered by the government's policy of forcing on distributors surplus stocks of alcohol manufactured from molasses and sugar. Supply of motor alcohol has been uncertain and irregular, owing to the lack of dehydration plants in the country, and the quantity used in motor fuel mixtures, though not inconsiderable in itself, forms a relatively small part of the total motor fuel consumption.

Kerosene sales have only just recovered to the pre-crisis level. Industrial progress is reflected in figures of demand for heavy oils, the striking increase in which has been considerably assisted by the large amount of coastwise bunkering business done between the different ports situated at intervals along Brazil's enormous coastline. That lubricating oil demand has not yet recovered to the pre-crisis level is probably to be explained by increasing economy in lubricating oil consumption, due partly to improved engine design and partly to higher quality lubricants.

Brazil is at present entirely dependent on foreign imports for her requirements of oil products, but for many years past considerable sums have been expended by the Government on the search for petroleum within the country. Since 1920 it has spent approximately 60,000 contos (about $3,250,000) on numerous drilling operations, in the course of endeavours to discover oil sources in the southern states, the coastal belt and the lower Amazon valley. So far this exploration work, which is continuing, has not produced results of importance.

GENERAL

Theoretical and Practical Considerations on Obtaining Polymer Gasoline—R. Fussteig, ACTUALITIE CHIM. ET IND., vol. 37 (1937), No. 3, pp. 853-860.

As is well known, polymerization of hydrocarbons is a process of mutual saturation of free valencies among unsaturated molecules. Therefore, in order to produce polymer gasoline it is necessary to start from a raw material containing unsaturated molecules; that is to say, olefines. If no olefines are present, they must be formed. Natural gas and refinery gas contain little or no olefines and in order to make gasoline from such gases, or in fact from any saturated hydrocarbon, they must be treated in such a way as to create free carbon valencies.

According to the point of view here presented, when a hydrocarbon, for example methane, is heated to a high temperature (pyrolized), it is broken up in two ways: one or more carbon linkages are ruptured so as to liberate carbon with four valencies: (=C=) and one or more other linkages are broken to present two free valencies: (— CH_2 —), which latter is the characteristic olefine linkage. These olefine linkages join together to produce larger molecules characteristic of liquid gasoline, whereas a portion of the hydrogen remains free.

Current theory that the cracking of heavy oils is simply a direct breaking-down of large molecules into small ones, in the author's opinion, is a little too simple. What really happens is that pyrolysis in all cases sets free either two or four carbon valencies. He illustrates his theory by supposing the case of an oil poor in hydrogen, say $C_{30}H_{46}$, which is subjected to pyrolysis. Such a molecule will break up according to the reaction:

$$C_{30}H_{46} \rightarrow (-CH_2-) + 7C$$

Here the free carbon will separate as coke and the (— CH_2 —) groups will rearrange themselves according to the prevalent circumstances of temperature, pressure and time of reaction.

In this reaction the free carbon is a loss, but at the same time methane is also pyrolyzed we have this reaction:

$$CH_4 \rightarrow (-CH_2-) + 2H$$

The seven atoms of carbon produced in the pyrolysis of the heavy oil, and which would ordinarily be lost as coke, are immediately transformed by the hydrogen from methane according to the equation

$$7C—14H \rightarrow 7—CH_2—$$

so that the whole process reduces to:

$$C_{30}H_{46}—7CH_4 \rightarrow 37(-CH_2-)$$

On this basis the author offers a new process for producing polymer gasoline. Heavy oil poor in hydrogen passes into the tube furnace A (see diagram) where it is heated to 475-485 deg. C. and arrives in the reaction chamber I which is filled with a suitable catalyzer. Here carbon atoms with four and two free valencies are produced. In the meantime methane is compressed in the tube furnace B and

Familiar to many oil men are the famous "Ox Teams" that hauled equipment at Ranger, Texas, back in 1917 when the discovery well, McClesky No. 1, led the way to the development of the great Ranger Pool. Within a single year the field reached 60,000 barrels daily—a boom that put Ranger on the map and helped meet the tremendous war-time demand for oil.

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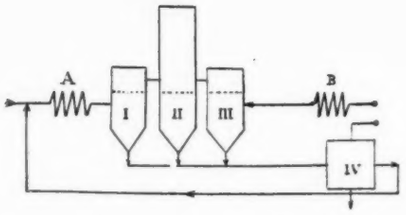
OIL AND GAS WELL CHEMICAL SERVICE



temperature of about 720 deg. C. and passes into reaction chamber III filled with a mixture of sulphides or tungsten, molybdenum and manganese as catalyst; here the methane is broken down to $-CH_2-$ and free H. The various products formed in the reaction chambers I and II meet in reaction chamber II, which is also filled with an appropriate catalyst. The condensible products are separated in the apparatus IV, from which the residual products are returned to the cycle.

On the basis of experimental results actually obtained it is found that when 100 kg. of heavy oil is cracked and 1,000 cu. ft. of gas is pyrolyzed (in separate processes) the yield is 105 kg. of distillate. When the two operations are combined as described above the yield of distillate is 145 kg.

Abuse in Handling Tubular Goods.—L. R. Smith, before AM. PETROL. INST., Colorado Springs, June, 1937.

After recommending that the Institute's "Code on Field Care and Use of Pipe" be followed, the author discusses improper methods of handling pipe from mill to consumer and in use of the pipe—giving in detail the damage resulting, which often causes unnecessary expense in well completions. Detailed suggestions are given regarding loading, unloading, field handling by truck, and protection of threads against sand and grit. The author gives torque and speed to be used when making up pipe joints in the field, with cautions on removing grit, in use of lubricants to prevent galling, use of worn elevators, and in force to be used in handling long strings of pipe in a well. The paper is profusely illustrated with photographs showing damage that can be prevented by proper handling.

Gasoline Blending with a Ratio Flow Controller.—John W. Brown and J. M. Jones before AM. PETROL. INST., Colorado Springs, June, 1937.

A ratio flow controller is a composite instrument consisting essentially of a flow meter and a flow controller so related that the rate of flow in a primary line as measured by the flow meter determines the rate of flow in a secondary line by setting the flow controller which actuates a control valve in the secondary line.

The apparatus is explained with the aid of a diagram.

In operation, the laboratory determines the desired blend of a given base and light gasoline. The loader is given the percentage blend and the exact resulting gravity. The loading line is opened to a single car, and loading started at low rate. The ratio controller is set to give the correct ratio of the two stocks, and the blend gravity checked. After the blend ratio has been established, the loading proceeds at any desired rate. Over a day's loading the maximum variation in gravity after the first car is 0.1 deg. A.P.I. The variation in percent evaporated at 150 deg. F., which is the control point, is 0.5 percent.

BOOKS

Synthetic Rubber—by W. J. S. Naunton, introduction by Sir Wm. J. Pope; published 1937 by the MACMILLAN COMPANY, London; 159 pages; 7s. 6d.

This is the first book on synthetic rubber to be published since the monograph by S. F. Schotz in 1926, which dealt only with the chemical aspects of the subject; Naunton's book is the first to deal with both its technical and economic aspects. As head of the rubber laboratories of Imperial Chemical Industries, Ltd. the author is qualified to speak with authority on the subject.

The work contains nine chapters devoted to the history and the economic aspects of synthetic rubber, the borderland between rubber and resin, the chemistry, physics, technology and applications of synthetic rubber, synthetic rubber latex and the future outlook. Most of the technological discussion relates to neoprene, the DuPont product synthesized from acetylene through vinylacetylene, which is converted into chloroprene. As regards the future outlook, this must of necessity remain speculative; the present position is that the available synthetic rubber products are complementary to natural rubber and provide the rubber manufacturer with a new raw material that should help him to extend his markets.

The interest which the petroleum industry may have in synthetic rubber lies in the fact that the oil industry is in a position to supply certain raw materials convertible into rubber-like substances—butyl alcohol, for instance, which is convertible into butadiene and which appears to be the base of the Russian synthetic rubber industry as it was of the German attempts to make a rubber "Ersatz" during the war. Whether synthetic rubber will become an adjunct of the petroleum industry remains to be seen, but the acetylene product already appears to be useful in this industry, as in the fabrication of oil resisting hose.

Petroleum Production—by Wilbur F. Cloud; published 1937 by UNIVERSITY OF OKLAHOMA PRESS, Norman, Okla.; 600 pages, 280 Figs.; $5.00.

The author states that he has written this volume as a treatise on oil production methods and fundamentals, and to present the subject matter in a form that can be used as a general reference for the oil company executive, the student and the practical production engineer. Naturally, the author is well aware that the production of oil is a huge subject, and that every oilfield has its own drilling and production problems; to cover all the matters relating to every field would obviously be impossible in a single volume. What the author endeavors to do, therefore, is to compile the more important information pertinent to those phases of production that engineers and operators everywhere have to deal with.

From this standpoint he treats of legal phases of petroleum production; oil sands and production relations; oilfield development; oilfield power and prime movers; oil well completion; flowing oil wells; air-gas lifting equipment and methods; surface equipment and methods for pumping wells; underground pumping and pumping problems; cleaning and reconditioning oil wells; repressuring oil sands; gathering, gauging and shipping crude oil; preparing crude oil for the market; oilfield water problems; production of natural gas; and storage and storage problems.

The author has divided his 600 pages among these varied subjects with nice discrimination in the placing of emphasis. Due to rapid progress of oil production technology and the dearth of treatises on current methods, this volume is well calculated to provide the busy engineer, as well as the student, with a panorama showing the present state of the art of producing oil.

Drilling Mud: Its Manufacture and Testing—by P. Evans and A. Reid, published by MINING AND GEOLOGICAL INSTITUTE OF INDIA, Calcutta, and INSTITUTION OF PETROLEUM TECHNOLOGISTS, London; 236 pages, 98 illustrations, with many tables and formulas; $5.00.

This treatise is a part of the Transactions of the Mining and Geological Institute of India, vol. 32 (1936). The book is essentially a review of the literature of the subject and an exposition of experimental results obtained in the laboratories of the Burmah Oil Co. Ltd. The subject is approached from two angles: manufacture and testing of drilling mud and its physical properties, their definition, measurement and application. The discussion is confined mostly to physical properties of muds without particular reference to the chemical aspects.

Manufacture of mud at central plants and at individual wells is dealt with extensively; also the methods of reclaiming and reviving used muds. Viscosity stands out as the most important characteristic of a drilling mud, so the authors stress the importance of agitation temperature, pressure and other factors that might affect the viscosity. A valuable feature of the book is the extensive discussion of various instruments and the technique of methods used in evaluating physical properties of drilling muds, such as weight, viscosity, thixotropy, surface tension, water separation (syneresis), differential settling, salt content, colloid content, plastering power, etc.

Mud technologists, whether they are at the moment interested in the physical, chemical or practical aspects of a drilling mud, or whether they embark on mud research that would be facilitated by knowledge of what has already been done in this field, will do well to have this treatise at their hand. It may be added that the work is written and arranged so as to make it easy for the reader to grasp the essentials of the various subjects.

Reactions of Pure Hydrocarbons—by Gustav Egloff, published 1937 as AM. CHEM. SOC. MONOGRAPH NO. 70 by Reinhold Publishing Corp., New York; 900 pages 6-in. x 9-in.; $16.75.

This bulky volume is presented by the author as a critical correlation of the widely scattered work of more than 1,200 investigators, who down the years have made their contributions to knowledge of the chemical natures and behaviors of pure hydrocarbons. His intention, as stated in his preface, is to provide workers in hydrocarbon chemistry with a record not only of what has been accomplished, but also a source of ideas for future researches.

The petroleum industry certainly provides a vast field where inspiration and new ideas may be turned to good account. Almost unbelievable quantities of hydrocarbons are available all over the world, besides the world's reserves of crude oil the oil industry is in a position to furnish an even greater quantity of raw material; and still in the offing are the estimated 300,000,000,000 bbl. of hydrocarbon oil potentially present in oil shale deposits. Here is a field of incalculable extent, where ingenuity and enterprise may make new conquests for the well-being and comfort of the human race. For the orderly prosecution of this conquest it is necessary and desirable that each forward step be correlated with previous steps, so that lost motion and wasted effort may be avoided. When a busy man like Dr. Egloff, abetted by his associates, devotes ten years to the collection and arrangement of the results of more than 1,500 separate investigations published in many languages he puts oil chemists and the oil industry generally in his debt.

In a brief review it is impossible to give more than a general indication of the scope of the work. It is divided into seven chapters, one for each of the seven recognized hydrocarbon groups: paraffins, olefins, acetylenes, aromatics, cycloparaffins, cycloolefins and terpenes. Within these groups the known facts about the chemistry of each individual hydrocarbon and its behavior toward various thermal, electrical, photochemical and catalytic agencies and its reactivity with other hydrocarbons or with unrelated substances are summarized; the table of contents giving the list of such topics covers 8½ pages in double column, while more than 50 pages are required for the author and subject indexes. The text is easily readable and plentifully interspersed with explanatory and critical remarks.

The immediate beneficiaries of this monumental treatise will be the technologists working on petroleum, gas, rubber, plastics, naval stores and synthetic organic products; beyond these it will be of interest to research workers throughout the realm of organic chemistry.

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Official Figures for Soviet Oil Operations

	Crude Production (bbl.)	Daily Average (bbl.)	Run to Stills (bbl.)	Drilling (ft.)
January	15,476,300	499,233	13,977,000	448,308
February	13,247,500	473,029	12,167,400	359,317
March	15,800,000	509,608	13,900,000	522,100
April	15,900,000	530,000	14,200,000	512,000
May	16,600,000	535,451	14,600,000	523,600
June	16,250,000	534,516	14,200,000	520,000
Total 6 Months, 1937	93,273,800	512,010	83,044,400	2,885,325
Total 6 Months, 1936	95,786,100	526,300	83,388,400	3,388,589
Total 1936	191,694,100	523,754	173,408,200	6,958,916
Total 1935	176,688,100	497,713	146,705,000	4,858,465
Quota 1937	225,120,000*	617,000	200,000,000	9,240,000
Quota 1936	213,500,000	584,931	175,000,000	7,100,000
Quota 1935	212,310,000	458,042	171,500,000	5,214,000

*Revised from 241,500,000 bbl. Crude conversion: seven barrels = one ton.

SOVIET OIL EXPORTS

Product	Jan.-Apr. 1937 Tons	Rubles
Crude	40,457	1,439,0
Gasoline	228,189	13,695,0
Kerosene	97,794	7,474,0
Lube oil	65,519	7,981,0
Diesel oil	2,431	86,0
Gas oil	136,842	7,895,0
Fuel oil	238,266	8,537,0
Paraffin	1,881	994,0
Others	1,119	
Total 4 months, 1937	812,498	50,051,0
Total 4 months, 1936	939,196	53,284,0

EXPORTS TO INDIVIDUAL COUNTRIES

England	206,187	12,555,0
Spain	94,058	6,913,0
Germany	77,809	5,306,0
Japan	49,706	3,431,0
France	44,848	3,291,0
Sweden	28,969	2,581,0
Italy	17,591	1,117,0
Iran	13,717	941,0
Denmark	11,155	905,0
Belgium-Luxemburg	9,491	1,197,0
Lithuania	8,420	557,0
Turkey	7,036	580,0
Finland	5,463	495,0
Esthonia	4,622	384,0
Switzerland	1,559	191,0
Mongolia	1,353	244,0
West China	1,340	287,0
Afghanistan	1,286	590,0
Others	475,776	10,584,0

RECENT TRIALS of so-called Trotzkyists and diversionists for sabotage in the Soviet Socialist Republics basic industries and military forces—resulting in minimum penalties of demotion and removal from office—are apparently but the beginning of a nation-wide purge of no mean proportions. In every field of endeavor where there have been failures of some sort the dragnet hauls in saboteurs, traitors and class enemies. Well-known names are continually being mentioned in connection with wrecking and negligence in exposing sabotage, graft and corruption.

Many heads of the oil industry have been prosecuted for various offenses. More recently Batulin, former head of Soyuzneftexport in France and later head of Aviatop, which controls all refineries outside of Baku and Grozni, was removed —he subsequently disappeared. Another leader labeled as a Trotzkyist and removed has been Yeffuni, vice-chairman of Soyuzneftexport and head of Inner Distribution. As has been previously reported in these columns, Petersen, head of Baku, was removed in May. This removal co-incided with a considerable improvement in crude oil output of that region for the first time this year, and from individual reports of operations in the larger fields it is evident that this improvement may continue. Although several fields of Baku are still behind plan the improved operations at Stalin, Lenin and Ordzonikidze fields have broken the stalemate and raised the general statistics for all Baku from between four and six percent below plan, to between two and four percent above.

It appears to be the belief in certain Soviet circles that similar improvement could be effected at Grozni, and other areas which are not producing their quotas, by removing the heads of the fields. An accompanying table shows the planned and actual crude production of Soviet oilfields in June and from this one could almost prophesy as to where next the ax will fall.

Plan Fulfillment of Soviet Oilfields in June

Field	Actual Output (Barrels)	Planned Output	Percent of Plan
Baku	440,000	432,550	102
Grozni	55,000	80,000	68
Maikop	25,000	31,500	79
Bashkiria	18,300	36,500	50
Emba	7,500	14,250	52
Voroshilov	3,000	15,200	19
Kalinin	1,300	2,050	63
Sakhalin	6,700	7,000	95
Turkomaneft	7,500	9,850	76

Crude output for all Soviet oilfields is still below plan as the total for the first six months of 1937 is well under the corresponding figure for last year. Baku fields have incurred arrears of about 7,000,000 bbl. of crude and about 200,000 tons of gas during this period, and to end the year according to the program set out it will be necessary for an output of at least 465,000 bbl. per day to be maintained. This would require all the idle wells to be brought under production, and it is uncertain as to whether the Baku management can cope with the 1,000 wells.

Similar arrears have been reported in drilling and the general routine is very unsatisfactory, despite the fact that individual drilling at special wells has been completed in record time—one at Kala was sunk to 7,200 ft. in 40 days. Lack of pipe has slowed down progress and the Libknecht plant, main supplier of pipe, is reported to have made deliveries of only about 40 percent of Baku's requirements during the first quarter.

Soviet Annual Oil Exports

(Tons)

	1932	1933	1934	1935	1936
Crude	526,000	527,000	459,000	207,000	167,000
Gasoline	2,018,000	1,296,000	1,119,000	658,000	419,000
Kerosene	829,000	570,000	436,000	416,000	383,000
Lube oil	187,000	253,000	305,000	308,000	253,000
Gas oil	627,000	676,000	650,000	516,000	545,000
Fuel oil	1,870,000	1,435,000	1,300,000	1,134,000	835,000

Another parallel is found in refining which fulfilled only 85 percent of plan during the first six months of 1937. This is due principally to deficiencies incurred at the Aviatop refineries. New construction has been retarded and the group of plants scheduled to come on stream at the end of 1936, with the exception of a cracking installation at Baku and another unit at Grozni, were not completed in time. The refineries at Berdiansk, Odessa, Kherson, Ufa, Orsk, Moscow, two installations at Saratov, and several units at Grozni are still under erection. Neither Glavneft, at Moscow, nor local construction offices know when or whether they will be completed in 1937. Several of these plants were scheduled to come on stream in June, others in July and August, but although a few have the main installations fairly near completion the auxiliaries have been neglected almost entirely. This is especially so in the case of Odessa, supposed to come on stream in June, and as yet no road construction has been undertaken to provide access to the refinery from center of distribution.

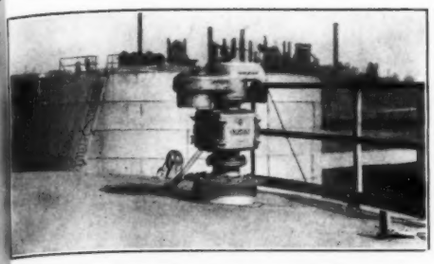
The steady growth of gasoline output in Soviet Russia during the past seven years is indicated in the accompanying table.

Soviet Gasoline Production

Year	Barrels
1930	13,769,000
1931	15,547,000
1932	19,460,000
1933	18,550,000
1934	19,705,000
1935	14,700,000
1936	29,484,000
1937 (Plan)	47,600,000

Among the guests expected at the Geological Congress in Moscow are George Walter Tirrel, professor of petrography at Glasgow University, James Richardson, mining engineer, Arthur Davis, biology professor, and David Williams of Royal School of Mines, London University.

J. WEGRIN



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A REPRESENTATIVE of Irish National Refineries Ltd. has written to WORLD PETROLEUM calling attention to one passage in an article published in the May issue relating to the project for establishment of a refinery in the Irish Free State. This passage contained the statement that application of the company to the Industrial Credit Corporation (a body which advises the government of the Free State on the advisability of extending financial guarantees to industrial projects) had been "unsuccessful." This statement, we are assured, is not in accordance with the facts and we gladly publish this information.

AMONG THE EQUIPMENT MEN

R. D. HEATH has been appointed manager of the New York sales division of the Westinghouse Electric Company, New York. Specializing in mining and electrical engineering at the University of Arizona and Columbia University, he entered the Westinghouse student course in 1924. He became associated with Westinghouse Electric International in 1926 and since 1929 has been closely identified with the company's activities in the mining and petroleum industries.

R. D. Heath

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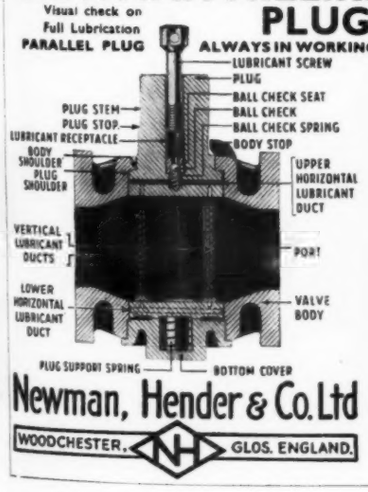

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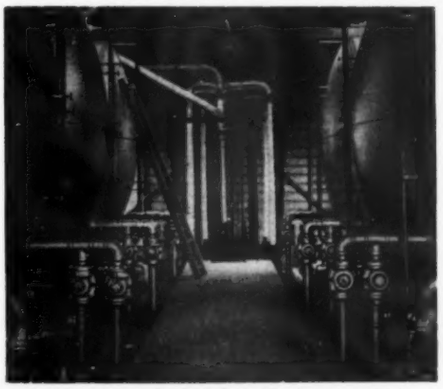
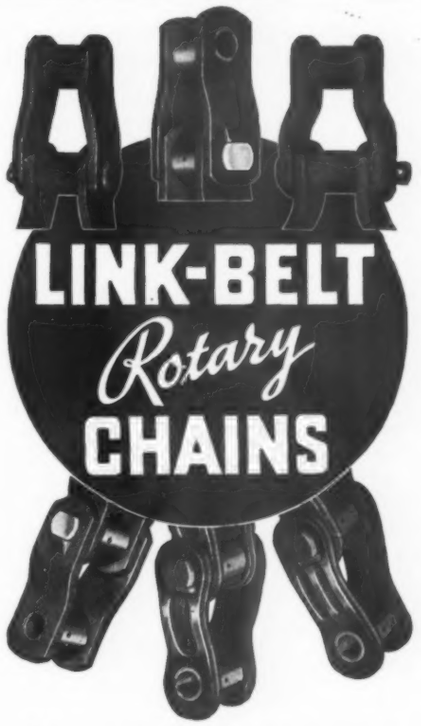


Installation showing N-M Valves on Gasoline Storage Tanks



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CORRECTION

IN TABLE II of Dr. William Mautner's article "Estimate of Oil Company Assets," in the July issue of WORLD PETROLEUM, the Pan American Petroleum & Transport Company is incorrectly shown as an affiliate of Standard Oil Co. (New Jersey). Actually 78 percent of the ownership of Pan American Petroleum & Transport belongs to Standard Oil Co. of Indiana. In Table I of this article the value of Indiana Standard's holdings in Pan American is included both under Standard Oil Co. of Indiana and under a separate heading for Pan American Petroleum & Transport. The grand total market value of the securities of Standard Oil Co. (N. J.) is shown in Table I as $1,377,690,571: the correct figure as given in Tables II and III should, of course, be $1,877,690,571.

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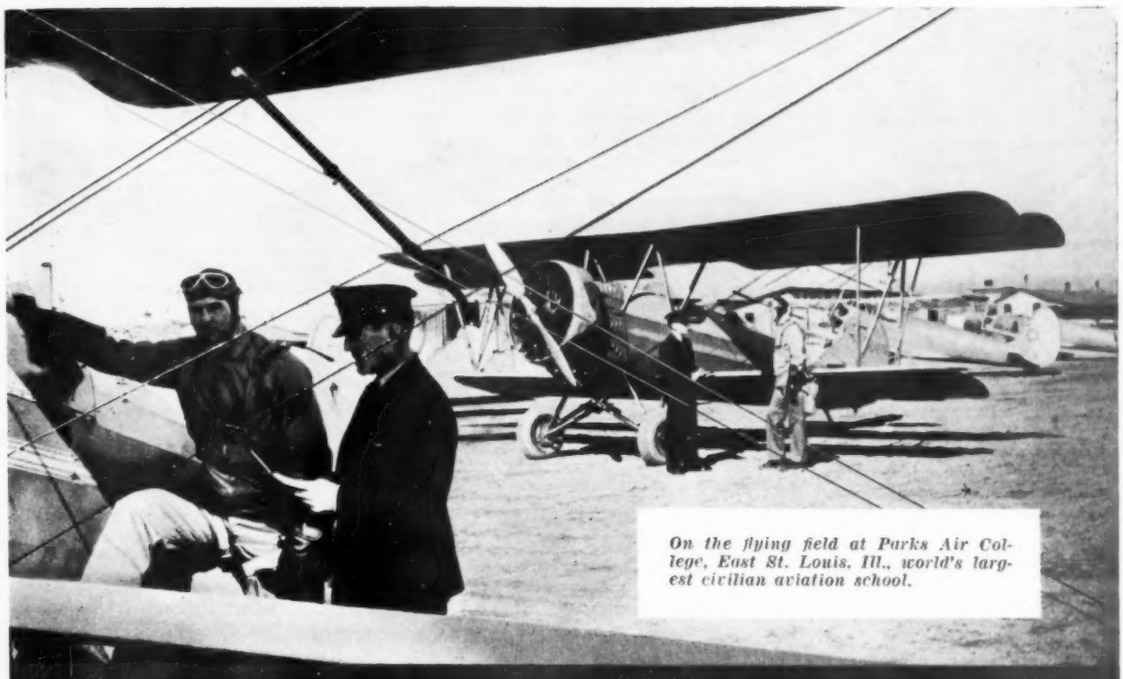

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